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CHART OF RADIANT POINTS OF METEORIC SHOWERS IN THE NORTHERN HEMISPHERE AND TO 20° OF SOUTH DECLINATION, BY W. F. DENNING.

W. W. PAYNE.

We are fortunate in having in hand so promptly, by the kindness of the author, a copy of his new catalogue whose full title is:—"General Catalogue of the Radiant Points of the Meteoric Showers and of Fireballs and Shooting Stars observed at more than one station."

A great part of this general catalogue was compiled some time ago, but the work has since been extended, and brought down to the present time, and published, in full, very recently, by the Royal Astronomical Society, as part of Vol. LIII of its Memoirs. The arrangement of the catalogue is progressively according to right ascension and the radiants which nearly coincide in apparent astronomical places are grouped together with the dates of their manifestation. This will enable anyone who wishes to determine the radiant of a shower of meteors to know at a glance whether or not it has been observed before, and what time of the year it was active. The catalogue is accompanied by a handsome, full-page, lithographic plate, indicating the position of the radiants with the number of each in the index list. The circles denoting the position of each radiant on the chart are so shaded as to show approximately the number of observed positions, which have been secured, from which to locate the average position of each on a general chart.

We have thought so much of the usefulness of this excellent device, that we have copied it, in full size as it appears in the original Memoir, except in regard to the order of the matter at the bottom of the page. We are sure our readers will appreciate this chart if they have any interest in the study or knowledge of meteors. But to make a study of it for observation in more than a casual way, the reader should have a copy of Mr. Denning's Memoir in hand which has been so carefully and thoroughly prepared that no brief description of it, like this, will at all do justice to the paper or its distinguished author. To give our readers some idea of the labor involved in it, we ought to go

back to 1886. In Vol. 47 of the Monthly Notices of the Royal Astronomical Society, page 35, appears a paper by Mr. Denning on the Distribution of Meteoric Streams, in which he says, the compilation at this time consisted of 3,035 radiants deduced from 82,000 meteors, while we notice in this paper that the present catalogue contains 4,367 radiants, and that the total number of projected meteor-paths from which they were determined is approximately 120,000. These figures give some idea of the years of time, and the pains-taking labor involved in the masterful piece of work before us, but they suggest nothing of the many details of work which must all be faithfully considered and applied at the proper time and place, although no visible marks of all this appears in the results on the charts, or in the descriptions or tables of the printed page. If one point is mentioned concerning the arrangement of the catalogue our meaning will be more plain. On page 203 of the Memoir Mr. Denning says: "Had the catalogue been arranged according to date only, references would have been difficult and troublesome, inasmuch as there are considerably more than 50 showers (of meteors) in play on any and every night of the year, and, moreover, certain (in fact the great majority) of these displays are not confined to limited periods, but extend their activity over several weeks, and in many cases over several months. And if the positions had been simply assorted according to right ascension after the manner of a star catalogue, and without any regard whatever to declination, references would have been equally difficult, for there are same hundreds of positions varying in declination in about right ascension 45°, 60°, 350° and 330°. The method adopted was therefore considered the most suitable one for the purpose of consulting the catalogue, and the author having had occasion to test its utility has always found it affords both a convenient and expeditious means of reference."

This citation is given not so much to show the arrangement of the catalogue, important as that is, as it is to call attention to the incidental facts mentioned in regard to the number of radiants in the sky that are active at the same time, the length of time that the showers continue, the ability to recognize meteors that belong to particular radiants and finally to assort those evanescent bodies and classify them in a way to make a record for reference that shall be lastingly useful.

The first table is a summary of leading results on which the catalogue is founded. It covers a period of more than 60 years and embraces the results of all known and experienced observers

of meteoric showers since 1833. This summary contains the places and years of observations, names of publications in which the results appear, total number for each observer generally, the number observed from January to June, and the number observed from July to December, separately, and the whole number of meteors of each observer or observers working together, in the final column.

The distribution of the 4,367 radiants in groups covering two hours of right ascension each, exhibits a remarkable prevalence in the first six hours east of the vernal equinox. This portion of the sky contains the November Andromedids, the August Perseids and the October Orionids, all of which are rich radiants; but in addition to these, Mr. Denning says there are very many other meteor streams in the same region, so that the radiants clustered between right ascension 1° and 60° are fully twice as many as those found between 151° and 210°. This suggests that meteoric streams are either very unequally distributed in space, or, that they appear to be so from some cause not clearly understood. The following little table, taken from page 207 of this Memoir, plainly indicates this wonderful relation:

R. A.	Radiants.	Per-centage.	R. A.	Radiants.	Per-centage.
1° to 30°	515	11.8	181° to 210°	201	4.6
51 " 60	763	17.5	211 " 240	261	6.0
61 " 90	416	9.5	241 " 270	295	6 8
91 " 120	347	8.0	271 " 300	353	8.1
121 " 150	280	6.4	301 " 330	348	8.0
151 " 180	233	5.3	331 " 360	355	8.1

Mr. Denning is of the opinion that in the summer and autumn the orbital path of the Earth passes through a region of space exceptionally rich in meteors, whereas in the winter and spring it lies in celestial fields of great scarcity. This may be the true explanation; it doubtless is the best one that can now be offered in the absence of more needed data to carry the discussion further. If the meteoric streams are in fact unequally distributed in space, then this simple fact is sufficient to explain all, for any clustering of radiants of almost any kind might naturally be expected. There is no apparent reason why meteors and meteoric streams should be in uniform distribution in space any more than any other class of celestial bodies, as for example the planets and comets of the solar system, or, indeed, the starry hosts in depths of space. The presumption is plainly in Mr. Denning's favor.

If space were at command it would be profitable to follow up the details of this interesting catalogue, and bring to notice the

many curious characteristics belonging to individual streams of meteors as revealed by the many, many showers that have been carefully and earnestly studied during the last 60 years or more. But the better way to do this for all those who are sufficiently interested, is to secure the few standard papers and elemental books on the subject and read and ponder their contents. It is also most useful to observe the showers of the more prominent streams at least, and thereby gain a vivid knowledge of the facts that can in no other way be so well and fully realized.

This Memoir is timely as well as other papers on the same general subject recently written by Mr. Denning in view of the great Leonid shower predicted for November next. It is already certain that this expected shower will receive more attention, and be observed more widely and thoroughly in this country and abroad, than has been true of any other display at any time. The aid that is being realized from photography in the use of a group of cameras at New Haven recently has some promise for the future which will certainly not be neglected when the next November Leonid display occurs.

Observers everywhere should be ready for their best work on that occasion. If such a shower, as occured at the last two displays of the Leonid stream, in 1833 and 1866, notably the former, should appear at the predicted time this year, it will be a celestial view never to be forgotten in the life-time of the fortunate observer.

RE-DISCOVERY OF HOLMES' COMET (1899 *d*).

C. D. PERRINE.

For Popular Astronomy.

This comet was re-discovered on the morning of June 11 with the 36-inch refractor. The conditions were good, the sky being very clear and the star images steady. The comet appeared as a round nebulous mass about 30″ in diameter but very faint and with but little central condensation. It was about on the limit of visibility with the 36-inch telescope—not brighter than 16th magnitude and was somewhat difficult to observe with any illumination of the wires, owing to the absence of any well defined center.

Following is the first position secured,

1899 June 10^d 23^h 8^m 44^s Gr. M. T.
α 1 15 31.57 δ +17° 29′ 39″.0

The comet was found by means of an ephemeris computed by Zwiers and published in No. 3553 of the *Astronomische Nachrichten.* A comparison of the above position with the ephemeris gives the following residuals—

Obs.—Comp. α $+28^s$ δ $+4'\ 54''$

Three sets of ephemerides were computed, and the above residuals are from the middle or most probable place of the comet. These residuals are remarkably small when we consider that the orbit was based on observations covering but four months and that the first observation was five months after perihelion passage. It is interesting to note that the probable error of the time of revolution as deduced from the calculations by the method of least squares was 0.7 day and that the actual observed error is well within these limits being but 0.3 day. The theoretical brightness of the comet based upon unit distance from both Sun and Earth was 0.0118 at the time of the last observation on March 12, 1893, while on June 10, 1899, at the time of rediscovery it was 0.0333. From this comparison it would seem that the comet is actually much fainter than at the last appearance.

This comet was so remarkable in many ways that it is hardly necessary to repeat much of its history which is doubtless recalled by most astronomers. A few of its most striking characteristics may be mentioned, however. It was discovered on November 6, 1892, by Mr. Edwin Holmes, of London. It was then visible to the naked eye and remained very bright for some two weeks or more, during which time considerable change was observed in its structure. It then lost much of its light but on January 16, 1893, it was observed to brighten up suddenly, being described as like a nebulous star of the 8th magnitude. After this outburst it faded rapidly, the last observation being on March 12, 1893.

Its orbit is more nearly circular than that of any other comet, lying wholly between the orbits of Mars and Jupiter. It traverses a path, therefore, among the asteroids and its connection with them was suggested but never proved.

In the matter of its spectrum it was also remarkable. Comets usually give a continuous spectrum for the nucleus and a spectrum for the coma and tail composed of three bright bands. The spectrum of all parts of this comet was continuous, with scarcely a trace of bright lines, showing it to be shining by reflected light.

The comet was well placed for observation by southern astronomers in the summer of 1898, and about as close to the Earth as it will be in the fall of the present year for northern observers.

The comet is now on the opposite side of the Sun from the Earth but it is moving rapidly north and the conditions are improving.

LICK OBSERVATORY, University of California,
1899, June 12.

THE APPARENT SIZE OF THE SUN.

CHARLES H. CHANDLER.

FOR POPULAR ASTRONOMY.

All who have had occasion to examine the celestial sphere, in company with others, have noticed the wide differences in the estimated distances between any two bodies in that sphere as seen by different observers. Of course a brief period of observation, with any correct thought of the true relations between the bodies apparently scattered over the concave, serves to eliminate from the mind all recognition of distances other than angular. But a class of tyros is likely to make some very remarkable queries, such as asking the name of "that star about three feet below the moon", a distance so entirely obvious to the inquirer that he is perhaps greatly astonished to be assured by the general voice of the rest of the class that it looks as if it were ten or a dozen feet distant.

Evidently these variations in apparent distance are due to an unrecognized difference in the estimated distance of the celestial vault from the eye, unrecognized, probably on account of the absence of all intervening objects serving the observer semi-unconsciously as standards of measurement. But an experience of twenty-five years with classes of youth inexperienced in such observations has led me to believe that the wide differences in these estimates can be explained by reference to a principle not unlike that underlying the errors which we are likely to make in terrestrial observations, when all intervening objects are too unfamiliar to afford a satisfactory basis of comparison, and when changed atmospheric conditions invalidate our judgment resting on the clearness or dimness of vision.

I recall a visit to an isolated New Hampshire peak, where the barren rocks afforded no standards of comparison of known size, but allowed me to be deceived by the unusually clear atmosphere, so that I burdened myself with a load of wood designed for a fire upon the summit of a slightly more elevated peak apparently less than half a mile distant. But after wearying my-

self with the load while travelling more than half that distance, and proceeding unburdened nearly as much farther, I secured a second supply which in turn proved almost too much for my endurance before reaching the peak, where previous experience had warned me that fuel would be sadly needed.

So, too, having removed from the Atlantic coast, where my previous life had been spent, to a region of broader outlook and clearer atmosphere in Ohio, I found, while travelling along the unfamiliar level roads, that I was likely to consider men who were approaching me hardly larger than children of a dozen years, until, after an unexpectedly long approach, the error in judgment was revealed; and it required months of residence to enable me to acquire the ability to estimate with reasonable accuracy the distance to some place clearly in view, but as yet unvisited by me.

Possibly a fly moving across a neighboring window gives, at first glance, a pang of righteous indignation directed toward the neighbor's hens and their proneness to cultivate our garden, a feeling quickly succeeded by the peculiar chagrin caused by the recognition of our erroneous estimate of distance.

In observations of the heavenly bodies the conditions are such as make such errors especially probable, while all basis for the correction of the first impression received is either lacking, or is of such a character as requires more or less comparison and reasoning. Hence it results, I believe, that at a very early age children form their conceptions of the distance to the overhanging vault dependent upon their knowledge of the objects associated in their vision with the more distant bodies apparently located in that arched canopy. I recollect one small lad who, like most young boys, probably saw the Sun rise much less frequently than it passed from his vision behind, or nearly behind, the barn of the man who each day furnished the family supply of milk. He saw the Sun disappear there at the distance of forty or fifty rods every evening, and in the morning it was revealed working its way upward from the other side of the glen. So this boy evolved from some part of his interior consciousness the firm conviction that the milkman's son, Will, every morning bore the luminary, which had settled down to rest at his father's barn the evening before, back across the glen in the wheelbarrow which so often brought him the expected milk. I never had an opportunity, after learning this somewhat peculiar solar theory, when I might question its originator concerning the dimensions of the Sun permitted by his scheme; but evidently it was only sufficient-

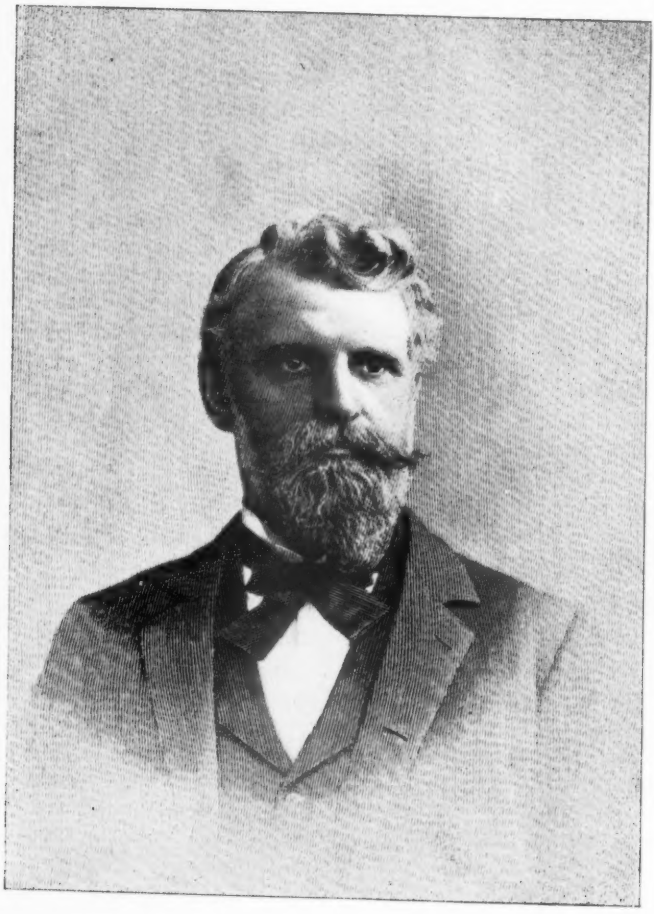
ly large to make a suitable load for the familiar wheelbarrow; and, if the lad's estimate conformed to the principle which I have been led to accept by the very numerous inquiries which I have made of the members of classes coming under my instruction, the Sun in that boy's thought occupied scarcely more room than the half dozen little family milk-cans which constituted the usual burden of that vehicle.

The inquiries which, as I have said, I have been making for so long a time, have been especially directed to the apparent size of the Sun and Moon; and because to most eyes the Moon seems to differ at different times more than the Sun, of late my attention has been more particularly directed to reports about the brighter luminary. I have found that with different observers the apparent size of the Sun varies from the size of a large wheel, afterward more definitely described as six feet or more in diameter, to the size of a silver dollar. This last estimate, however, has bsen presented only during the past year or two, and therefore I was at first naturally inclined to ascribe this new opinion to an increased estimate of the size of the silver dollar due to political considerations; but further inquiry developing the fact that this unusually small estimate was confined to scholars coming from the same class of the same high school, that they had talked the matter over together to a considerable extent, and that sometimes it seemed to them much larger than that, the smaller appearance being only occasional, I was forced to the conclusion that there had been such u authorized consultation as disqualified those young persons for jurors in the case.

Rejecting those connected estimates, I have found no estimate smaller than the top of a coffee cup, or, on further questioning, between three and four inches across. From this size, or a little larger, to nearly or quite four feet in diameter the estimates varied in nearly every class. The larger conceptions have been only rarely presented. The largest one, (of six feet or more,) was that of a young man whose earliest recollection of the Sun was of seeing it sink behind the distant waves of the Pacific. My own early ideas of the Sun I easily recall. I mentally fitted it to the top of my mother's best coffee cups, a trifle larger than those in ordinary use. The home of my early days was amid the New England hills, where the morning Sun appeared over a knoll perhaps twenty-five rods from the door, while in the evening it sank behind a hill a little more distant, but still very near.

The principle suggested by these extreme cases I have found to be sustained by a very large majority of the cases in which I

PLATE X.



Ambrose Swasey

have made inquiry. Each class of students generally contains some who have formed no definite conception of the size of the Sun. These students are likely to be among the number of those who have no definite recollection of the places of most frequent observation of the Sun in their early years. Not infrequently their homes seem to have been often changed. Very rarely can they tell whether their first experiences were of the Sun's rising and setting behind near or distant objects.

But among those who at the time of reporting have a distinct judgment of the apparent size of the Sun, or, if that has been displaced by a correct angular conception, still are able to recall their previous estimate, and who also remember the conditions under which their unschooled vision was attracted by its appearance, among these, usually comprising about half of the class, the exceptions are rare to the rule that the estimate of apparent size varies as the distance of the horizon behind which the sun rose or set. It is especially marked that the average estimate of size is much smaller among New England youth reared amidst its hills than with those whose vision made first acquaintance with the broader fields or perhaps prairies of the West.

One other cause I suspect to have an influence upon this conception of size, although my investigations have been too nearly confined to the students under my instruction to furnish the careful comparison necessary to justify a decided opinion. But a limited number of examples has led me to think it not improbable that heredity has some weight here; although of course it is difficult to separate this effect, if it really exists, from results similar in character due to unconscious education of the child by the parent.

COLLEGE, RIPON, WISCONSIN.

AMBROSE SWASEY.

JOHN A. BRASHEAR.

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A retrospect of the mechanic arts, going back no further than the present generation, brings before us a panorama of marvelous advancement, covering every phase of invention, rich in the development of that which contributes to the economy and comforts of life, and the advancement of human knowledge. Indeed, it would seem that there has been more than one magic lamp, to

bring forth genii at whose command a Forth or Brooklyn bridge, a ten thousand-ton steamer or a mighty railroad is brought forth in a night, like the beautiful palace of Aladdin and his fair bride. America has on its tablets of fame the names of many who have contributed to this wonderful advancement, master minds that have taken hold of the various forms of energy and bidden them contribute to the wants of man.

When a new branch of science presses its claims, there seems to be a law of nature that with the new need comes the new man, ready to take hold of and develop it, at least so far that it may easily be taken up by his successors and carried to completion. The writer well remembers holding in his hands the little induction coil made by Michael Faraday, containing in its few pounds of iron and steel the embryo of the mighty dynamos and motors of the present day. Yet what great minds have arisen to develop and foster this potent form of energy since the time of Faraday!

Compare, if you will, the little telescope of Galileo in the museum of Florence with the magnificent astronomical engines of the Lick or Yerkes Observatories in the United States, and you have a typical illustration of the marvellous progress in astronomical mechanics, most of which is the product of the present century. And so it is with every phase of science, particularly in that branch which we have a right to call the science of mechanics.

Of the eminent mechanics and engineers who have contributed much toward the advancement of knowledge in America, by far the larger number claim some one of the New England states as their home. The list is a long one, and "Yankee ingenuity" was a common expression even half a century ago. In fact, not only is New England the centre of many of America's greatest industries, but the impress of her genius has been stamped upon every part of that big country. Many of the master minds that have been developed within her borders have found new opportunities in the Western manufacturing states, and have done honor to their early homes, and it is with pleasure that the writer presents to the readers of this magazine a brief sketch of such a New Englander who sought a field of labor away from the scenes of his birthplace.

Ambrose Swasey was born in Exeter, N. H., his ancestors being among the early settlers of New England, coming to America from England in the year 1638. The fine old farm in Exeter, upon which his grandfather lived to the great age of ninety-four,

and where his father spent his long life from 1800 to 1891, is now in Mr. Swasey's possession, and he often goes back to the old homestead where he passed so many of the happy days of childhood.

Mr. Swasey's father was one of the old New England type of men who are fast passing away, having that force of character, will power and energy sufficient to attack any obstacle. When the Boston and Maine Railroad Company commenced to lay its tracks across his farm, he not only vigorously opposed any attempt to mutilate and, as he thought, desecrate and spoil his property, but he fought them in the courts and then invested the money secured for damages in the stock of the railroad company.

Mr. Swasey received his education in the "Little Red School House" of the district, and his after life has shown that the seed sown by the old schoolmaster fell upon good ground. At the age of eighteen he entered upon the machinist's trade in Exeter, and in 1870, in company with his present partner, Mr. Worcester R. Warner, he left the granite hills of his native state to go into the employ of the Pratt & Whitney Company, at Hartford, Conn. His energy and ability soon became manifest to his new employers, and his aptness in the solution of mechanical problems was so thoroughly appreciated, that the remark, "Send it up to Swasey," was a common one with them.

While in charge of their gearing department, he invented and perfected the epicycloidal milling machine for producing the true theoretical curves of the teeth of gears, and a few years later he made another advance step in the solution of that difficult problem, inventing an entirely new process for generating and cutting spur gears. At one of the recent meetings of the American Society of Mechanical Engineers, Mr. Swasey presented a notable paper, entitled "A New Process for Generating and Cutting the Teeth of Gear Wheels," which at once took a high rank among the valuable contributions to the annals of that society. At the World's Fair he exhibited an automatic gear cutting machine, embodying the principles of this new process, which attracted the attention of many eminent American and foreign engineers on account of its being a practical solution of the very important theory of the interchange system of gearing. In 1880, Mr. Swasey resigned his position with the Pratt & Whitney Company and, together with his present partner, established in Cleveland, O., the business which has since grown to such large proportions. Mr. Swasey's inventive and mechanical genius has emphatically manifested itself in the design and construction of

the fine machine tools and astronomical instruments made by his firm.

It seems a most fortunate circumstance that these two men, Ambrose Swasey and Worcester R. Warner, should have associated themselves together as partners, for although the making of astronomical instruments was not in their original scheme when starting the business of machine construction, Mr. Warner's taste for astronomy, and his interest in the appliances used by astronomers, combined with Mr. Swasey's love for artistic design, and his ability as a mechanical engineer, very naturally led them to take hold of the questions pertaining to such instruments.

In recent years observatories and instruments had increased to such dimensions in America that most intricate problems, requiring the highest engineering skill, were demanding solution. The largest refracting telescopes constructed previous to 1880 were the 26-inch telescope of the United States Naval Observatory, at Washington, D. C., the 27-inch of the University of Vienna, Austria, and the 30-inch instrument of the Pulkova Observatory, Russia; but the Lick telescope, as projected, was to have nearly half as much more light-gathering power than any refractor that had hitherto been constructed, and the difficulties of mounting such an immense instrument are enormously greater than those attending the construction of a smaller one.

Imagine the great object glass, weighing 500 pounds, poised at the end of a steel tube fifty-six feet long, weighing, with its accessories, more than five tons. The tube must be practically free from flexure, and at the same time be so delicately mounted on its bearings that when it is pointed to a star, and the image of the star is bisected by the spider lines of the micrometer, it shall move as steadily as the heavens.

The instrument must be as firm as a rock, its bearing must move as frictionless as it is possible for mechanism to make them, there must be no lag in the great optic tube, which receives its impulse from the driving clock, and its motions must respond readily to the touch of the astronomer as he sweeps from star to star, from planet to planet, for at each new setting he must move many tons of material.

It is sometimes required to use a magnifying power of a thousand diameters upon the stellar image in order to measure the distance of its components, if, perchance, it be a double star. Let us see what this means! Suppose the telescope tube with its massive counter-parts vibrates one-thousandth of an inch, and

we place in the micrometer our eye-piece magnifying a thousand times. This means that we also magnify our vibration in the same ratio, giving the star an apparent motion of one inch. It needs no further illustration to show the delicacy of such measurements and the problems that enter into the construction of one of these immense astronomical engines.

In 1886 the Lick trustees invited four firms to submit designs for the 36-inch telescope, which was to be the largest and most powerful ever constructed. Two of the competing firms were from abroad and two from the United States. The fact that this was the first instrument to be devoted to the triple purpose of visual, photographic and spectroscopic work, brought out many new problems in addition to those required on account of the instrument's great size and completeness, and the astronomer having the work in charge frankly admitted that he feared the requirements were beyond the possibility of accomplishment by the engineer.

The competing designs for this great telescope were sent to the Lick trustees in San Francisco, and after careful consideration the plans submitted by Messrs. Warner & Swasey were accepted, and they were awarded the contract, although their price was the highest. The design of this important instrument was carefully studied in every detail, and the highest standard of excellence was maintained throughout. It was finally erected on Mt. Hamilton, in California, during the winter of 1887 and 1888 under Mr. Swasey's personal supervision.

The Observatory was built upon a mountain peak 4,200 feet high, on the top of which there was scarcely room for the 6-inch telescope previously carried to the summit by Professor Burnham to test the purity of the mountain air; indeed, it required the blasting and removal of 42,000 tons of rock before a space large enough for the Observatory could be obtained. The erection of the Lick telescope was so far away from the "base of supplies" that it was a herculean task to transport all the parts of this huge instrument, weighing over forty tons, to the top of the mountain, over a newly-made road, sometimes in a driving snow storm, with the wind blowing from sixty to eighty miles an hour.

During his stay on Mount Hamilton Mr. Swasey made many delightful acquaintances, and when these lovers of astronomy and mechanics happen to get together they bring up many pleasant memories and experiences. Some of those who were thus associated with Mr. Swasey, and whom he held in high esteem for their sterling qualities of hand and heart have gone to their rest,

—among the number, Captain Richard Floyd and his estimable wife. Captain Floyd was president of the board of trustees and did all in his power for the successful issue of the great enterprise, made possible by the will of James Lick.

At last the work was finished. Mr. Swasey started the great driving clock, the mighty engine of astronomy obeyed its commands, and the optic tube, pointing to the skies, was ready to unravel the mysteries that had hitherto baffled the searching eye of the astronomer. What this great telescope has given to science through the labours of Holden, Burnham, Barnard, Keeler, Campbell and other astronomers has already become historic, and the end is not yet.

> "Priest ministrant, within this mighty fane
> Whereon thou standest now is holy ground,
> Divinest gift is thine to gaze the first
> On glories yet unseen by mortal eyes."

The instrument was such a departure from the usual construction that it was severely criticized. It stood, however; as all such work must, on its own merits, with the result that in 1890 the United States Government decided that the Naval Observatory at Washington must be rebuilt and equipped with new and modern instruments. and the contract for the great telescope and meridian circle was awarded to Messrs. Warner & Swasey. This equatorial is one of the most beautiful and symmetrical mountings ever constructed, and while there is not a single superfluous part, every possible accessory is provided for the convenience of the astronomer.

When the 40-inch Yerkes telescope was to be constructed there was no longer a question as to the style of mounting, and the work was given to the makers of the Lick instrument without competition. This telescope will long be remembered as it stood in the main aisle of the Liberal Arts building at the World's Fair in 1893, with its great tube reaching far above the galleries of that immense building. It has just been erected at the Yerkes Observatory, at Lake Geneva, Wis. Its great dome, 90 feet in diameter, with elevating floor, 75 feet in diameter, having a rise and fall of 25 feet, was also constructed by Warner & Swasey. The whole equipment of this modern achievement in optical and mechanical engineering, will in its turn, reveal to us new worlds now hidden in the depths of the heavens.

It is apparent from the success of these famous telescopes, which are to be dignified as feats of astronomical engineering, the great need indeed develops great capacity. In the construc-

tion of instruments of such beautiful design, combining strength rigidity, precision and delicacy of motion, Mr. Swasey has accomplished a notable work for the cause of science, while placing himself high in the ranks of American engineers.

About two years ago Mr. Swasey's firm commenced the task of constructing a dividing engine for automatically dividing circles, to be used more especially with meridian instruments where precision is of supreme importance, and where the most perfect engine that has been, or ever can be, devised and constructed will be none too good for the work.

It would require many magazine pages to give a history of all that has been done on this difficult problem since the days of Tycho Brahe; yet today the number of dividing engines that are sufficiently accurate for the demands of modern astronomical measurements may be counted on the fingers of one hand. The best engines have errors, and the question is, how much can these errors be reduced.

As one-third of an inch subtends an angle of one-second of arc at a distance of one mile, it may readily be seen how minute the measurements will be on the periphery of a circle, say of three feet diameter. As there are 1,296,000 seconds of arc in a circle and all seconds must theoretically have the same value, it is easy to conceive the difficulties of dividing a circle in which the errors shall be less than a second of arc. Homogeneity of material, proportionate parts that will equally respond to small changes of temperature, and many other factors enter into this difficult problem, aside from the final corrections of the dividing mechanism.

Every approach to perfection, be it never attained, brings greater assurance to the astronomer that his results will be commensurate with the faithful and conscientious work he puts into his measurements.

It has cost an immense amount of study and application, as well as a large sum of money, but from the present indications Mr. Swasey has the promise of a full reward for his labor, as already a practical test of the engine shows that it is more accurate than any heretofore constructed. Mr. Swasey is especially interested in construction as applied to engineering and architecture, and his travels at home and abroad have enabled him to study and become familiar with much that is ancient and modern in that line.

In his address, delivered as president of the Civil Engineers' Club of Cleveland, on "The Specialist in Engineering," there are

many paragraphs that fairly glow with expressions of his love for the beautiful in architectural design. Surely he would have been a master in this profession had he adopted it as his life work. Mr. Swasey was married before he left the soil of New England, and Mrs. Swasey has made the home life contribute in a large measure to his happiness and almost enviable success.

Mr. Swasey is past president of the Civil Engineers' Club of Cleveland, and a charter member of the American Society of Mechanical Engineers. He is often consulted in regard to important engineering matters and is called upon to assume various trusts in the commercial and business interests of the city of his adoption.

His genial good nature is apparent at home or abroad, and all who have the pleasure of his acquaintance will assent to the verdict, that he is a man among men.

THE PARALLAX OF THE GEGENSCHEIN.

J. EVERSHED.

Professor Barnard in his very interesting article on the Gegenschein, which is abstracted in the June number of the *Observatory*,* mentions my theory, which assumes it to be a tail to the Earth, produced by the escape of molecules of helium and hydrogen away from the Earth in a direction opposite the Sun. He remarks, however, that the absence of any parallax is fatal to this theory.

Perhaps the following considerations will show that the absence of any observable parallax does not invalidate the tail theory.

First, I assume that our tail is a very long one, that is, of the order of millions or tens of millions of miles. This assumption is justified by the analogy of comets' tails.

Secondly, that the gases composing the tail are in a state of extreme tenuity, and the light which we see is the integrated result of the excessively feeble reflexions coming from all distances along the axis of the tail, *excepting* those nearer parts where it will be hidden in the Earth's shadow.

Now it is only the nearer parts, say within the Moon's distance, which could show a horizontal parallax exceeding one de-

* Professor Barnard's article was originally published in full in the April number of this Journal.

gree, and an angular displacement less than this would be impossible to observe with any certainty in so ill-defined and faint an object.

Judging from the large apparent size of the gegenschein, it would seem unlikely, however, that the tail would be wholly hidden within the Earth's shadow between us and the Moon's distance; there would be outlying parts which, it might be thought, should give evidence of parallax.

But would these outlying nearer parts be visible at all? Suppose that the tail were presented to us sideways instead of end-on, I believe that it would be absolutely invisible, even on the darkest sky. According to my view it is only on account of the enormous depth of excessively rare gas through which the line of light passes that we are able to perceive anything whatever. For this reason I think that the nearer portion of the tail, lying outside the central parts obscured by the Earth's shadow, would not reflect enough light to be separately visible.

Admitting that the gegenschein *is* an extra terrestrial phenomenon, and that it *is* due to reflected sunlight, the absence of any indication of a dark centre, such as would be caused by the shadow of the Earth projected upon it, shows that the light, or a large proportion of it, must come from a region beyond the apex of the shadow-cone, so that, so far as I can see, it comes to this: either we must assume that there exists at an immense distance from the Earth, yet always in the same relative position to it, a round disk or roughly spherical mass of matter (dust-like or gaseous); or that there is an elongated stream of matter, the axis of which is directed towards the Earth.

The latter seems to me to be the least difficult to imagine, because the outward flow of matter along the stream, as in a comet's tail, explains the constant relative position.

The weakest point in my theory, I think, is this:—If the tail spreads out in the form of a cone say of 15 degrees, the intensity of the reflected light ought to diminish very rapidly with the distance from the Earth, and a large proportion of the total illumination as seen from the Earth should in this case come from the nearer parts of greater density. Consequently there should be evidence of the Earth's shadow seen as a dark space in the centre and evidence of parallax in the outer ring of light.

With regard to Mr. Anderson's objection, of course a more satisfactory theory would be one which explained both the gegenschein and the zodiacal light. I do not see, however, why the mere optical superposition of the gegenschsin upon the zodi-

acal band should show that there is any real relation between them. Nor do I see why it should be considered to be "obviously connected" with the zodiacal band.

Professor Barnard states, in the article referred to above, that the zodiacal band is not always present. No distinct band is visible in August and September or in March, so that at these times the gegenschein is just as obviously an independent phenomenon.—*The Observatory.*

KENLEY, 1899, June 4.

THE EFFECT OF MOUNTAINS ON THE QUALITY OF THE ATMOSPHERE.

A. E. DOUGLASS.

For Popular Astronomy.

The great Colorado Plateau which occupies the northeastern portion of Arizona varies in elevation by gradual slopes from 5,000 feet in the valley of the Little Colorado up to something over 7,000 feet at distances of 50 miles on either side of that river. The Little Colorado River is central in this plateau and its course is in general from southeast to northwest. The higher part of the plateau to the west of this, culminates in the group of mountains called the San Fancisco Peaks, whose highest point is 12,800 feet above the sea. Westerly from these peaks stretches within 40 miles a line of mountains rising to 9,000 or 10,000 feet, Sitgreave's, Kendrick's and Bill William's. If one travels 30 or 40 miles southwest of this group of great peaks, he reaches what is called the Rim, that is the edge of this plateau, which, running in a northwest and southeast direction, forms its southwestern boundary. Beyond that the land drops away very rapidly to the south and west.

The San Francisco mountains which form the highest part of this plateau consist of a close group of elevated points, forming, perhaps, the ring of an ancient crater. Their sides fall away in all directions to the general level of the plateau, save on the southeast, where Elden Mountain or "Mesa" stretches eight miles away from the main summit at a constant elevation of over 2,000 feet above the level of the plain. In the same general direction as Elden Mountain, smaller lava flows extend to the southeast and south from the main peak and between two of these in a valley 300 feet below the tops of these lava streams,

is situated Flagstaff at a distance of 9 miles from the peaks. The Observatory is situated on the lava stream to the west of the town 350 feet above it and a mile distant from its centre. Seen from the Observatory the mountains, therefore, occupy a conspicuous place above the northern horizon. The main peaks reach from NNW to NNE, rising to an altitude of about 8 degrees, distant 9 miles; and Elden Mountain extends from NNE to ENE, rising to an altitude of 6 degrees and distant 4 to 8 miles. It is evident, therefore, that when winds blow from the north and northeast over this plateau that they must pass over these mountains before reaching the Observatory.

Knowing the location of these mountains with reference to the Observatory, it became evident during the early investigations of atmospheric currents in 1894-5 that there was some alteration in the direction of local winds produced by these great elevations. It was found that a telescopic current from the north at great elevation was frequently accompanied by one from the easterly direction or by a local easterly wind, evidently an eddy produced by these mountains in the great stream of air. Another more serious effect was suspected, namely, that the mountains had an effect upon the winds passing over them, causing very bad seeing.

During the present winter, we have had many nights in which fine currents came from the north and produced seeing that rendered work wholly useless. A series of tests on these currents, or air-waves, showed that they were not necessarily near the dome nor did they seem to come from the surrounding forest. Thinking then, that they came from the mountain, the final method of testing the truth of that assumption evidently was to compare at the same moment the currents at Flagstaff with those at some point so far removed that the mountain could have no possible effect. This comparison was effected in an advantageous manner by means of a concave mirror, 12 in. in diameter, 7 ft. 6 in. in focus, which was recently purchased from the firm of Alvan Clark & Sons. Supplied with a leather case and carried from point to point by the writer on a freight train, it has served as a means of examining the atmospheric currents at points widely separated in distance but within short intervals of time.

On Feb. 18th, the writer, taking the mirror, left town at 8 P. M. (7.34 Local Time) on an East bound freight train and at 8.50 made an observation 11 miles east of town. At 9.40, an observation was made 21 miles east of town. From 10.30 to

17.20 he observed at Winslow, 58 miles east (by rail) and then returned to a point 32 miles distant and made an observation at dawn. Observations were begun at that same point as the first stars appeared on the following evening. Special tests were made of the currents passing down a Cañon 250 feet deep (Cañon Diablo) and at midnight, after further observations near the railroad station, the trip west was begun. An examination of the atmosphere was made at points 21 and 15 miles east of Flagstaff and at Flagstaff itself. On each of these nights Mr. S. L. Boothroyd made continuous observations at proper intervals in the 24-inch telescope of the Observatory.

As this is the first investigation of precisely this kind and the results are so definite and conclusive the entire observations are given in full below including the comparison observations through the telescope at Flagstaff. Those who have followed the writer's work on this subject will recognize the various data. In the top line is placed the hour and locality. Then follows a note giving such data regarding the locality as affect the appearance of the atmospheric currents; namely, the elevation above the sea, the direction and distance of the mountain peaks and the character or contour of the immediate surroundings. Then follows in a line by itself the star observed, and below that the currents observed, each in a single line beginning with the highest and most general current. Remarks about the twinkling, cloudiness or wind follow the list of currents. Notes and remarks in parentheses call attention to significant points.

While glancing these over, it should be remembered that conspicuous currents are more harmful than faint in any kind of telescopic work, that fine currents are far more harmful than coarse ones in planetary work and that the form called sheets does more serious harm to the seeing than any other form yet observed overhead at night.

The direction and size of currents are each variable in themselves and also difficult to estimate from the lack of comparison marks on the mirror or objective. As variations of 10° or even 20° in direction or 15 to 30 per cent in size must be considered of little importance.

During the two days included in these observations and, of course, for much time before, the San Francisco Peaks were partly covered with snow. It was very deep on the north side and on Elden mountain but had largely melted on the southern slopes although a fair amount lingered down to as low an elevation as that of Flagstaff.

Comparison Observations

of atmospheric currents at Flagstaff and points as far as sixty miles east.

Abbreviations.

The direction of the current is always followed by its size in inches; then its conspicuousness, etc:—v. = very, c. = conspicuous, m. = medium, f. = faint; cst. = constant or unchangeable, oc. = occasional; sw. = swift in motion; ord. = ordinary form of wave as seen in high and general currents; fl. = floating form, low and local; eels. = a variation of floating in which the "streaks" are fewer and more conspicuous; sh. = sheets produced by floating form in rapid motion; wr. = wrinkled produced by great thickness of floating form, with or without motion: mot. = mottled, only positively identified as characterizing a "pool" of quiet cold air such as settles in valleys at night; tw. = twinkling of stars on an arbitrary scale in which 0 = no twinkling and 10 = maximum twinkling.

February 18, 1899.

Observations in 24 inch at Observatory in Flagstaff, at an elevation of 7,250 feet.

S. L. Boothroyd, oberver.

7^h (= 14^h G. M. T. = 6^h 34^m local T.)

Betelgeuse, z. d. 30° ±

NxE (?)3.0-4.0 c. cst. sw.
NW susp. 2.4 (f) cst. sw.
NxE 0.8 v.c. cst. sw.

Seeing 0, much diffused light about star and much internal motion (boiling) of image.

Small wisps of cloud, but generally quite clear.

9^h 20^m

1st Mag. star. z.d. 25° ±

NxE 0.8 v.c. cst. sw.
Exs 0.8 v.c. cst. sw.

Seeing 0, very poor. Star nebulous, much diffused light. Seeing worse

Observations in 12 inch mirror at various points.

A. E. D. observer.

7^h 33^m Flagstaff.

In town, one mile east of Observatory. Elevation 6,900 ft. In an open valley sloping S.

On Capella.

NExN 0.7–1.2 c. cst.
Mot. same direction (?) Fl.

(The coarse currents seen at the Observatory were not noticed in the mirror being obscured by the mot. This current, about 1 in. in size is the one due to the mountain and which disappears in the subsequent observations in this column.)

8^h 50^m Cosnino.

At 11 miles east of Flagstaff, by rail, elevation 6,300 feet. San Francisco Peaks lie from WNW to NW, distant 9 to 14 miles and one isolated peak of 9,000 feet, 14 miles NNW. In a hollow, sloping E.

On Capella.

NNE 2.0-2.4 m.c cst.
W fl.

On Sirius.

Pulsating blotches, 3 in. across.

On Mars.

Fl. only.

9..07 Pollux tw. 2
Sirius tw. 8

than at 7ʰ but the boiling image is not so noticeable.

Small wisps of cloud here and there. Very marked halo around Moon.

(The easterly current is probably caused by an eddy from the mountain.)

9ʰ 39ᵐ Angell.

At 21 miles east of Flagstaff, elevation 5,800 feet. The Peaks lie Wxx to NWxw, distant 24 miles. On an open plain, slight slope to S.

NNE 2.4 m. cst.
NNW susp. 3.4 f. cst.
E and W fl very abundant, probably from engine or lanterns.

Cirro strattus clouds in streamers from N horizon to zeneith.

Twinkling of α Ursæ Maj. 4, altitude 45°, train in motion.

10ʰ 48ᵐ Winslow

At 58 miles east of Flagstaff by rail. Elevation 4,900 feet. The Peaks lie WNW to NWxw, distant 60 miles. The town lies in an open plain with a very slight slope to NE.

On Pollux.

NNE 2.4 f-m. cst.
NNW susp. 3.0 f. cst.
fl. all directions, probably from torches in train yard.

No other fine currents or mot. visible.

11ʰ 5ᵐ Observatory.

1½ Mag. star. z d. 30° ±

NxE	0.8	v.c.	cst.	sw.
NxE	2.0	v.c.	cst.	sw.
E	0.8	c.	cst.	sw.

Seeing about the same as at 9ʰ 20ᵐ. Halo around the Moon.

(This NxE or NNE. 2.0-3.0, evidently existed over all the region including Flagstaff and Winslow.)

11ʰ 0ᵐ Winslow, ctd.

South of town.

NNE 2.0 m-c. cst.
NNW susp. occasionally.
fl.
eels. from E.

12ʰ 20ᵐ Winslow, ctd.

On mound 25 feet high in E centre of town.

On R gulus, near meridian.

NNE 3.0 f. cst.
NW susp. 6.0 f. cst.
fl. very little, possibly from S.
eels. from W.

A 2 mile breeze from S. Star clear but in W haze rises to 60° altitude and in E up to 45°. Regulus tw. 1, Sirius, 9.

14ʰ 5ᵐ Observatory.

1½ Mag. Star. z.d. 15°
2nd Mag. star. z.d. 30°

NxE	2.4	3.0	v.c.	cst.	m.
NxE	0.8		f.	cst.	sw.
ENE	0.8		c.	cst.	sw.

14ʰ 25ᵐ Winslow, ctd.

On 10 foot mound, W of town.

On Arcturus, z.d. 30° ±.

NNE 2.4 m. cst.
W susp. 6 f. cst.
fl. a little from S.

Seeing about the same as at 9^h 20^m. Wind springing up from a little E of N. Sky more or less hazy all over; cloudy in N and NW and slightly in SE.

Currents faint but whole mirror seems to twinkle.

Very slight S breeze if any. Moon in thin clouds to W. Sky overhead very slightly hazy.

14^h 30^m.

At NW foot of mound.

Currents same as on top of mound except, in addition eels from SSW, coming around edge of mound.

14^h 55^m Winslow, ctd.

N of town on street level.
On Arcturus and Regulus.

NNE 2.0 m-f. cst.
Fl. more than at mound.

Stars tw. 0-2. Sky seems clear overhead. (These observations at different parts of the town were for the purpose of getting effect of adjacent town on seeing. The town is fairly circular in form and about two-thirds of a mile across. The houses are nearly all of wood, and at this hour there were no fires of any kind in it except in the R. R. engine house, freight yard and restaurant, lying along its S edge. There seemed to be very little bad effect from the proximity of the town and most of what there was, came from the railway houses, engines, etc.)

15^h 6^m Winslow, ctd.

On mound 25 feet high in E center of town, three blocks N of engine house. On Arcturus.

NNW 6.0 v.f. cst.
NNE 2.0 3.0 f. cst.
Fl. fairly numerous, from S, visible only with eye piece.
Currents faint, and slight general vibration.

Arcturus tw. 0, Regulus tw. 0-1.

15^h 20^m Winslow, ctd.

S. of town. On Arcturus.

NNE 2.0–2.4 f. cst.
fl. less than N. of town but not much different. No eels. Slight vibration or twinkling of whole of mirror.

Stars tw. very slightly; Arcturus 0, Antares 7.

17^h 15m Winslow, ctd.

In freight yard. On Arcturus.

NNW 2.4–3.0 m. cst.

fl. a good average, no increase with lateness of hour.

Arcturus tw. 1.

17^h 30^m left Winslow. 17^h 40^m dawn begins.

18^h 0^m Observatory.

2d Mag. star z.d. 30° ±

NNE 2.4–3 0 v.c. cst. m.

ENE 0.8 c. cst. s.w.

Very doubtful traces of NxE, fine.

fl. abundant.

Seeing very bad, about the same as before. Sky clear. Light breeze from NNE.

18^h 55^m Cañon Diablo.

At 32 miles east of Flagstaff, by rail; elevation 5,200 feet. The Peaks lie WxN to NWxW, distant 36 miles. On an open even plain with a slight slope to E.

On Jupiter; Venus and Jupiter, alone, visible.

"Sheets" from W. fine, c. cst.

Air, cold, from W. clear as crystal. (These "sheets" may have been from engine which was W of observer. Coarse currents rarely show on a planet.)

19^h 6^m Sun half above horizon.

FEBRUARY 19, 1899.

NOTES ABOUT CANYON DIABLO.

They had much fog here from middle of December, 1898, to early February, 1899, and at one time two feet of snow. This morning (Feb. 19, 1899,) the wind was W at sunrise, flowing directly down hill from Elden Mountain towards the Little Colorado. Now, at 3 to 4 P. M., the breeze is from N, in the general up-hill direction of the Little Colorado, and also about the same as the currents seen at Winslow last night. Very slight hazy clouds now visible.

Cañon Diablo, from which the station takes its name, lies one-third mile west of the station; it is 500 feet wide and its bottom is 250 feet below the surrounding plain. It lies in a north-east and south-west direction with a drainage toward the north-east.

(The tests made in the Cañon for characteristic currents occur in the following paragraphs.)

NOTE.

On this date the agreement between the two columns is not so exact but this is easily explained by the fact that all the stations occupied were in the lee of mountains which produced slight eddies in the streams of air.

6^h 30^m Cañon Diablo.

At bottom of Cañon. Cold air in lowest 20 feet of depth. Occasional flow of cold air down Cañon (sunset a few minutes after 6^h).

6^h 35^m.

On Mars; bottom of Cañon.

There seems to have been a general flow of air from NNW-WNW. From the Observatory this appeared to be of size 1.2 to 2.0 inches and was usually accompanied by a slightly finer current from about N. probably an eddy about the mountain. East of Flagstaff, this stream had waves of size 2.0-3.0 inches as seen from Winona, 17 miles south-east of the mountains, 2.4 inches at Angell, 24 miles east-south-east of the mountains, and 2.4-4.0 inches at Canyon Diablo, 36 miles east-south-east of the mountains. The finer currents were not visible from any of the places. When thus summarized the increase of size of wave with increase of distance from the mountain is noticeable.

$7^h\ 10^m$ Observatory.

On Alcyone, z.d. 20° ±

NW	2.0	c.	cst.	m.
N	1.0	v.v.c.	cst.	sw.
NNE	1.2	m.	oc.	

Seeing 0, stars nebulous and showing much motion, much as at $9^h\ 20^m$ last night.

N ± 0.9-1.2 c. cst.
Fl. c. down Cañon.

(Size always uncertain on a planet.)

$6^h\ 40^m$.

On Capella, from bottom of Cañon.

NWxw 6.0 c. cst.
W 2.0 c. cst.
fl. and eels. c. from near side of Cañon (evidently the cold air floating down toward the bottom).

(Few minutes later:—)

NNW 1.3-1.5 c. cst.
W 3.0 c. cst.

(Few minutes later:—)

Star 2nd to 3d Mag. in west, setting behind edge of Cañon, z.d. 45° ±

fl. very abundant; wr. and twinkling of whole of mirror.

Zenith stars tw. 2.

$7^h\ 10^m$.

On star between ties of high bridge over Cañon.

fl. very abundant (and other currents).

$7^h\ 22^m$.

On Capella, from bottom of Cañon. At this moment is felt the first distinct breeze down Cañon. It was preceded by

SW sh. down Cañon. 0.4 f. oc.

Very faint at first. It is now:—

NNW 4.0 m-f. cst.
WNW 2.4 m-f. cst.
SW sh. 0.4 m-c. cst. down Cañon.

$7^h\ 27^m$

Other currents and
SW sh. 0.4 c-v.c. down Cañon.
Vibrating or twinkling effect in coarse currents.

Feel constant gentle breeze down Cañon.

$7^h\ 35^m$

On Mizar, at low altitude but close above N edge of Cañon, looking through great thickness of down-flowing cool air, which is felt as a breeze from SW.

"Terribly" wrinkled appearance with conspicuous and great pulsations.

(The former, the wr. has been found to come chiefly from great thickness of fine currents and the latter, the pulsations, from great thickness of coarse currents.)

$7^h\ 40^m$.

Down-Cañon breeze has grown more conspicuous.

$7^h\ 53^m$ On edge of Cañyon; breeze Sxw.

$8^h\ 6^m$

On plain, near edge of Cañon; on Capella.

WxN ⎫ 2.4
to NW⎭ to 4.0 m. cst.
fl. susp. f. oc. mostly from S.
S susp. 1.2 f. oc. doubtful.
And on Mizar:—
S or N, prob. S coarse c. cst. colored.
W 0.8 ± wr.

Currents not nearly as bad as at the bottom of Cañon and lacking the SW sh. down Cañon.

$9^h\ 0^m$ Observatory.

1.5 Mag. star, z.d. 15° ±

NW	2.0	c.	cst.	m.
NNW	1.2	c.	cst.	m.
N	1.0	v.c.	cst.	m.

Seeing 0 but possible a trifle better than at $7^h\ 10^m$.

$10^h\ 0^m$ Observatory.

On Betelgeuse, z.d. 35° ±

NNW	2.0	v.c.	cst.	sw.
N	1.0	v.v.c.	cst.	sw.

Seeing 0, or about as at $7^h\ 10^m$.

$11^h\ 35^m$ Cañon Diablo.

At depot, on Pollux.

WNW
to NNW 2.4-4.0 f. cst.
No fl.
Vibrating or twinkling effect.

Breeze SW, light.

$12^h\ 45^m$ Observatory.

1.5 Mag. Star, z.d. 30° ±

NW 1.5 v.c. cst. v.sw.
N susp. — v.f. oc. m.
fl. abundant.

Seeing 0-1; better than for several days but yet very poor. Motion of image very great and very rapid nearly all the time.

$12^h\ 50^m$ Angell.

At 21 miles east of Flagstaff by rail; elevation 5 800 feet. The Peaks lie Wxn to NWxw, distant 24 miles. On an open plain, slight slope to S.

NW 2.4 m-c. cst.
Wxn 1.0 m-f. cst.
No fl.
(Wxn also shows on Mars.)

$13^h\ 0^m$ Angell, ctd.

On Regulus.

NNW 2.0 m.c. cst.
WNW 3.0 m.c. cst.
(No WxN—or other was wrong direction—and no fl. or sh.)

Breeze W and oc. Stars tw. 1.

$13^h\ 40^m$ Winona.

At 15 miles east of Flagstaff; elevation 6,300 feet. The Peaks lie WNW to NW, distant 17 miles. An isolated peak of 9,000 feet elevation, lies 14 miles NNW. In an open, shallow valley sloping N. On Arcturus.

NNW 2.0 f. cst.
WNW 3.0 f. cst.
WNW } from
fl. abundant, c. cst. } engine.

Arcturus tw. 1.

$13^h\ 50^m$ Winona, ctd.

On Regulus.

NNW and WNW 2.0 c. cst.
(No fl. or other fine currents.)

$15^h\ 15^m$ Observatory.

1st Mag. star. z.d. 25° ±

NW 1.2-1.5 m-c. cst. v.v.sw.
fl. abundant.
(No trace of N current.)

Seeing 0, not quite so good as at $12^h\ 45^m$ and motion of image more rapid and violent. Star has long fringes in rapid motion and the central image is much blurred.

$15^h\ 25^m$ Flagstaff.

At a point 1 mile east of Observatory, in open valley with gentle slope to S; on Arcturus.

NW susp. 3.0 v.f. cst.
Mot. NW and mot. NNE, and eels, all v.c.

Stars tw. 0-1.

Upon examining the observations of the first date, the effect of the mountains is at once apparent. The fine northerly and very harmful current seen at Flagstaff disappeared at a point eleven miles east of town. Probably the coarse current observed by Mr. Boothroyd was a genuine one and displayed the average size of wave pervading the great stream of air moving to the south but the contact of this air with the mountain peaks, covered with snow, or by rocks chilled by excessive radiation, resulted in the production of the fine conspicuous current. The change between Flagstaff and the observations made at Cosnino were so marked that at the time it seemed as if the character of the night had changed and I entertained misgivings with regard to the value of the observations but the records made in the 24-inch telescope at the Observatory show that the night not only did not change for the better but actually grew worse during the early evening and the results therefore, became very conclusive that high mountains have the most harmful effect upon winds passing over them.

The observations on the second night were not so conclusive as those on the first but yet are suggestive with regard to the de-

pendence of size of the waves upon their age. The two northwesterly currents or the single variable WNW—NNW current, observed from the stations along the railroad, indicated a stream of air from the general direction of the mountains and during the trip back to Flagstaff, the mountains, certainly an important source of these currents, were gradually approached and it will be observed that the currents become somewhat smaller and more conspicuous.

This decrease in size upon approaching the source of the waves or upon seeing them when their age is less, is what we would expect from theoretical considerations. Even in 1894, it was suggested that the coarse currents were high up in the atmosphere and, since then, that has been found to be the case in occasional observations upon clouds, and the theory has been formed that when the waves are first produced, that is when the air is first filled with irregularities in temperature and density, these irregularities are apt to be numerous and strongly marked but by the diffusion of the air and the equalization of temperature and density the separation of irregularities must become less marked and the irregularities themselves less numerous. Such a mass of air under observation must, therefore, present at first fine and conspicuous waves and at the end coarse waves which gradually become more diffuse and finally disappear, as do the streaks in a mixture of glycerine or syrup and water. The size, therefore, is a function of the age of the wave.

Besides depending upon the age, it is quite possible that the size at commencement of the waves is dependent upon the intensity with which they are produced, that is upon the difference of temperature between the air and the solid particles with which it comes in contact and from which it obtains heat or to which it gives heat. Very likely also the size is dependent upon the speed of the wind which passes over the heated or cooled surface; but in any case, these variations in size at starting are comparatively small, varying probably between one quarter of an inch and an inch from crest to crest. Mr. Boothroyd has occasionally observed the northerly current to grow finer as the night advanced, a change which may therefore be due the growing chilliness of the mountain peaks or to increased velocity of the wind in the later hours of the night.

One other investigation is found in this collection of observations, namely the effect of being in a narrow valley which forms a drainage channel for the settled cold night air. Cañon Diablo is 250 feet deep and 500 feet wide at the top. In the earliest ob-

servations from the bottom of the Cañon only local floating forms of waves appear, indicating that the chilled air was seeking the lowest point but an hour and a half after sunset and following a few preliminary indications a characteristic fine current appeared flowing down the Cañon, which was not visible from the plain above. This identified, (as has been done at other times) the source of that characteristic fine current.

The results now discussed regarding the effect of mountains on currents, the effect of age on size of waves, and the characteristics of valley currents show that this method of investigation with a mirror can be made a fruitful source of estimating the astronomical characteristics and qualities of any given region and it may be that in astronomical exploration, this cheap and portable apparatus will prove of the greatest use.

LOWELL OBSERVATORY, Flagstaff, Arizona.

July 5, 1899.

THE NAVAL OBSERVATORY.

WM. W. PAYNE.

Professor A. Hall, Jr., Director of the Detroit Observatory, Ann Arbor, Mich., has a letter in *Science* (July 14) concerning the management of the United States Naval Observatory. The object of the letter is to bring out very plainly points which Professor Hall says have been overlooked so far as he can learn. The first is, that the real intention of those members of Congress who sought to have the institution established in the beginning was that it should be devoted chiefly to scientific work. That the title, "Depot of Charts and Instruments" was added to it and a plea of utility made for it, "because it was feared that the public would not support a scientific institution. For this reason, also, the institution was placed in the Navy Department, since the salaries of the professors and officers engaged in astronomical work would come from the pay of the Navy, and would not appear under the Observatory appropriations." From these facts cited by Professor Hall it is easy to see how officers of the Navy in charge of the Observatory would naturally feel (and claim if they cared to) that the Naval Observatory really belonged to the Navy, for it was officered by law from that branch of the Government, and that the salaries of its officers were from funds appropriated to the Navy, and that it was the duty of

those in charge of that institution to make it, at all times a good and safe "Depot of Charts and Instruments," with presumably, some discretion for additional work in the interest of Navigation and kindred subjects. It then appears that the real trouble began with timid friends, in the outset, who caused an act of Congress to be passed creating the Observatory and providing for its management in a way not to represent their own best judgment, and that the consequences of such a step have been grave differences of opinion as to the proper control of it as a scientific institution. The real question then was and now is, are officers from the Navy, with the training they have, as likely to be fitted for a purely scientific position, as scholarly men who have spent all their lives in scientific pursuits, chiefly to prepare themselves for positions of just such responsibility as that now under consideration. To such a question there can be but one answer.

Another point referred to by Professor Hall is, that the chief ground of criticism against the Observatory has seemed to be the lack of a continuous, well-defined policy. The cause for this he ascribes to the variable duties of the line officers in charge. He says: "Our Navy has been built up at times, and then allowed to run down, and the line officers have had but little to do. At such times they want to control everything connected with the service, and the scientific work of the Observatory has had to go to the wall. This was the case for some years before the war of the Rebellion, and also about 1882."

Professor Hall does not question the ability of some of the line officers who have had charge of the Observatory, indeed he distinctly says a number of them have been "eminent men," and if time enough were given them, they could "learn anything and do anything. The reason why they did not do well in astronomical work usually was that it took them too far from the profession for which they had been trained."

From what has been said before it is evident to us that this is the second important point in the discussion, closely linked with the first, growing out of it and wholly dependent upon it. If the friends of the Observatory had not made a serious mistake in the outset in its plan of organization, it is not at all probable that the later generally bad condition of things could have happened.

Professor Hall next says: "Logically, I think the Naval Observatory should be placed under scientific management and taken from the Navy, but as affairs are really managed under

our government with a chance for the methods of the practical politician I am not so sure."

So far as we know, this opinion is very generally endorsed by astronomers everywhere in this land. It is emphatically the reasonable view of the case, especially if we do not give the politician too prominent a place in making or hindering a wise administration of a worthy plan of scientific work. It seems to us that the politician is not so much to be feared in this matter as its unwise and designing friends are, who make use of the politician to carry forward plans and scheming ready-made to his hand. The average politician does not know much about scientific work or its real needs. He is generally ready to do his duty as a legislator, if not posted, when it is made plain to him, and he will surely look after the interests of his friends. What is wanted to reach the root of the matter, in our judgment is, agreement among astronomers generally as to what is best, the formation of a plan to carry out what is adopted as a wise course and finally an organization of astronomers that shall have representation in the United States wide enough to make its influence felt in effective ways.

It is to be expected that the officers of the Navy in charge of the Observatory will oppose any change of plan of administration; that the committee on naval affairs in Congress will do the same and that all employees at the Naval Observatory, if they do anything, will likewise oppose such a movement. As we recall the history of previous efforts on the part of outside friends and astronomers to secure a needed change in the administration of the Observatory, these three sources of influence against the change were strong enough to defeat it at critical points of its progress. The naval officers interested were outspoken and very active, their influence in Congress was considerable. The professors and employees of the Observatory who best knew the conditions of things in detail were silent spectators in the main, possibly in deference to the views of their superiors, and possibly in view of a tenure of office that should hold to an honorable retirement. Unfortunate for the success of previous attempts as it was, we could not greatly blame the able professors of the Observatory for their inactivity for now we well know what it might have cost them if such a course had been pursued, especially if they had expressed their views in favor of a change at all prominently.

This state of things even now does not make any needed change in the administration of the Observatory impossible.

Whatever the opposition is it can be overcome. Something of an attempt has already begun in the meeting of astronomers and astrophysicists, held at Harvard College Observatory last summer. The beginning seems to be a good one, but how much will come of it will depend on how much real work is put into forwarding a wise plan, sustained by a wide and general interest that means work for many friends. Committees and resolutions only will accomplish very little.

THE SUN DIAL OF AHAZ.

J. MORRISON, M. D., Ph D.

FOR POPULAR ASTRONOMY.

My paper in the December number of this Journal has been criticised by Messrs. Saunders and Easton who have, in recent issues, set forth their views in such a manner that I feel justified in referring again to the matter in dispute. These gentlemen have been wrestling with equations (2) and (3) which are practically identical, and because they cannot determine from them a maximum value of θ in terms of h (the hour angle) they jump at the conclusion that I am wrong and that the shadow cast by AC (see diagram) must always advance and can never recede under any condition. A mere inspection of these equations is sufficient to show that they do not admit of the treatment which Messrs. Saunders and Easton propose, for the simple reason that h increases continually and φ is constant. The change of the direction of motion of CE and BE—the shadows cast by AC and AB respectively—depends on the Sun's *azimuth* and not on the hour angle, and the azimuth can have a maximum value only when the Sun culminates north of the zenith of the dial—the observer being in the northern hemisphere. Equation (5) gives the value of the hour angle when the azimuth is a maximum and equation (8) gives the maximum value of θ, all of which is explicitly shown in my paper. Since the hour angle is the great difficulty which these gentlemen encounter, let us remove it by the following process. They will, I presume, admit that equations (2) and (4) exist at the same time; eliminate h between them and we obtain

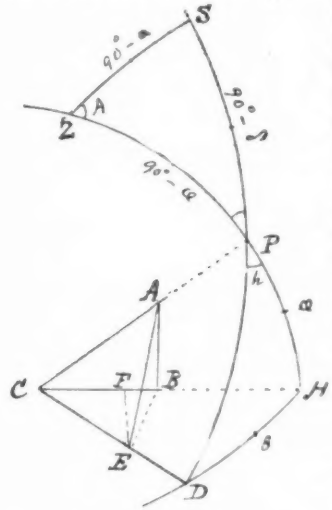
$$\cot A = \tan \delta \cos \varphi \sqrt{1 + \sin^2 \varphi \cot^2 \theta} - \sin^2 \varphi \cot \theta$$

from which we find in the usual manner

$$\tan^2 \theta = \frac{\cos^2 \varphi - \cos^2 \delta}{\cos^2 \delta}$$

or $$\tan \theta = \pm \frac{\sqrt{\sin (\delta + \varphi) \sin (\delta - \varphi)}}{\cos \delta}$$

which is identical with equation (8) deduced by an easier and simpler process. Mr. Saunders makes a slight transformation of equation (2) and obtains a result which is useless, if not absurd, and proves nothing. He also misrepresents me by quoting me as saying that the shadow can never go backwards except within the torrid zone. I have not published any such statement in my paper or anywhere else. Since these gentlemen do not follow my work correctly, I will now try to give the steps to take another view of the matter. Referring again to the diagram, *CE* is the shadow cast by the hypothenuse *AC*; the point *A*, common to both *AC* and *AB*, casts its shadow at E, and if we take any number of points in *AC* and through these pass a saw parallel to *AB*, thus cutting the stylus into a number of perendicular laminae whose heights vary from 0 at *C* to *AB* at *A*, the shadow of the vertex of everyone of these perpendiculars, will fall on the line *CE*, and if we remove any number of them, for instance *AB* and those adjacent to it, or some of the intermediate ones, the effect will be the same, *i. e.*, the line joining the shadow of their vertices will be *CE*, no matter what the number of these perpendiculars may be. The point *C* being stationary, the line *CE* will advance or recede according as the point *E* advances or recedes, and *E* is the shadow cast by the vertex of the perpendicular *AB*. Now suppose we place a stick perendicular to a horizontal plane—a level and smooth piece of ground will do, if nothing better is at hand—at any place north of the tropic of Cancer; its shadow at noon will fall due north and will *always* advance or move in the direction of the hands of a watch. If we incline the stick towards the north or place it parallel to the Earth's axis,



i. e., direct it to the pole, its shadow at noon will also fall north and will always advance. This latter is the case of the common sun dial. But suppose we incline the stick towards the south, that is to say, direct it to a point on the meridian *south* of the Sun, the shadow at noon will now fall south and not north as before and as the Sun moves westward across the meridian, the shadow of the vertex will move eastward or retrograde not only on the horizontal plane but on the plane perpendicular to the stick. We may erect any number of such sticks all parallel to the first but shorter so that the line joining their vertices may be directed to the pole, the shadows of the vertex of each when joined will form the line CE (see diagram) as already shown and the motion of this line around C as a centre is controlled or governed by the azimuth of the Sun and not by the hour angle as I have already stated. From sunrise until the Sun attains its greatest elongation with regard to the point of the meridian to which the stick is directed, the shadow or the line CE will advance; at the moment of greatest elongation it will remain stationary for an instant, then recede or go backwards until the Sun arrives at its greatest western elongation when it will for an instant again become stationary and then advance until sunset. So far as the motion of the line CE is concerned it makes no difference whatever whether the plane on which the shadow falls is horizontal or perpendicular to the stick; the latter position is the case of the Sun dial of Ahaz. The amount of retrogression of the shadow depends, as I have shown in the paper referred to, on the latitude of the place and declination of the Sun; if these are nearly equal ($\delta > \varphi$) the angle of retrogression will be small as was the case in question, viz., 10°, that is 5° on each side of the meridian. We do not know whether or not those degrees were identical with ours, but this is not a material factor in the case, all that is necessary for us to show, is that it is possible for the shadow to recede, or, in other words, the phenomenon was purely astronomical and one which any person can easily verify by the instructions I have just given, or we can proceed as follows: Take a circular piece of card board to represent the plane of the dial and at or near its centre erect a right angled triangle of the same material and having the angle ACB (see diagram) equal to 20° suppose, then at any place north of the tropic of Cancer—Iowa City, for instance—adjust it as near as practicable to the meridian and latitude of the place, when it will be seen that the shadow of the hypotenuse AC will, near the time of the summer solstice, behave as I have just stated.

In a former issue another gentleman asks to what extent I claim priority for showing that the shadow can recede. He might just as well have asked if I claim equation (4) as my own discovery.

Unfortunately I can claim nothing at all in this discussion for the reason that the direction and motion of the shadow of a perpendicular or inclined stick, have been known from time immemorial; they were known to the ancient Hindoos, Egyptians, Babylonians and Greeks, but are at the present day unknown to my learned critics. I never saw the work of Nonius to which the gentleman refers, nor have I even heard of Hutton's edition of the same. They are not well known, are now rare books and probably out of print long ago.

Another of my correspondents asks: "Does the shadow of the style of a sun dial recede for several days every year at every place within the torrid zone?"

To which I answer, no. If the dial is properly constructed the shadow always advances at every place on the Earth's surface, but on the Equator the line CE instead of revolving around C as a centre, moves parallel to the meridian but always towards the east.

The dial of Ahaz was not constructed for Jerusalem; it was probably brought from India by some person who presented it to the king; it required no extra graduated curves, as the shadow receded for a few days only near the summer solstice. The phenomenon which was then regarded as a miracle was perhaps observed for the first time by the prophet and may never have been again but if it was, it would only be regarded as a confirmation of the sign.

A POPULAR ASTRONOMICAL OBSERVATORY.*

GEORGE E. LUMSDEN.

The last instance to which your attention shall be invited is that of the Gesellschaft Urania of Berlin. This scientific society was founded in 1888 as a joint stock company, with a capital of 300,000 marks, about $100,000. In 1896 there were nearly 400 shareholders, who possessed a fine two-story building, fitted with all sorts of astronomical and physical apparatus, and erected in one of the public parks on a site presented by the Government. Shareholders have free admission to all the spectacular

* Continued from page 317.

and special exhibitions and receive a copy of the magazine, "Heaven and Earth," published by the society. The success of this purely scientific undertaking has been phenomenal and, notwithstanding the necessarily great initial outlay, and some difficulties, not anticipated by the founders, is now on a paying basis and in possession of a fine property. From the report for the year ending March 31st, 1894, the last in possession of the writer, it may be gathered that 25,210 family tickets were issued (5,043 to new applicants), and that the public attendance, which reached 117,617 paying visitors, included 26,400 visitors on special occasions and 10,000 pupils from the city schools. The income derived from all sources was more than $30,000. The astronomical equipment includes one reflector and the following refracting telescopes; one 12-inch, one 6-inch, one 5-inch, and one 4-inch. Complete details may be obtained from the literature issued by the Managing Committee.

We see what is being done in Europe and in the United States by public spirited men and women. Their example can and ought to be followed in Canada. In the United States, from the very public schools of the higher grades to the most ambitious colleges, there is rivalry in this field. The great universities are vieing, each with the other, in the splendor of their astronomical and astro-physical equipments, due, in some part, to the open-handed generosity of opulent men desirous to see in their own day some of the results of munificence wisely directed into popular educational channels. Munificence of this kind is royal, whether the patron be prince or private citizen. Science owes much to munificence, and nobly are her professional votaries striving to repay the debt. Her scrolls are rapidly filling with names illustrious by gifts. The glory of the Ptolemies is associated with patronage of literature and science. When all else that he did shall have been forgotten, it will be remembered that Frederic II. of Denmark, was the friend and protector of Tycho Brahé, and while the name of the astronomer lives, so shall that of his king. The name "Lick" will never be blotted from the page of Astronomy. If munificence becomes princes, how much more does it become rich men who, in giving, are giving that which is theirs by right of their own energy and thrift.

So far, munificence has done nothing in Canada for Astronomy. Not a public telescope pierces the Canadian skies, pure as those of more favored lands. But the day is coming when this reproach will be wiped away. When once they understand the needs of learning, wealthy men will come forward with substan-

tial assistance. We are hopeful for the future. There *is* a demand in Canada for astronomical knowledge, and that demand will be supplied.* So far as Toronto is at present concerned, the interests of observational astronomy are practically relegated to this Society, willing enough, but utterly unable to give full scope to its plans, conceived in the interest of the public. If this Society had the Observatory and apparatus it requires, it would give freely of its time and abilities to make the best use of the equipment. It is prepared to work with any corporation, or other body, or individual, who will submit and support any feasible scheme. Most of our members are beginners. Every one is a learner. We embrace all classes. Some of our members are teachers in the city schools, where they have practical experience that our otherwise laudable system is defective in that it causes neither the teacher nor the scholars to be taught anything worth knowing of astronomy. Any member of this Society who has a telescope will vouch for the truth of the assertion that there are in this city and in this country many people who are intensely interested in astronomy, and who wish to acquire sufficient practical knowledge to enable them to appreciate the descriptive statements contained in books and in magazines, and in the newspaper articles which, on special occasions, the best edited sections of the daily press supply to their readers. Children have sufficient imagination to be apt pupils in astronomy. No youth ever refuses an opportunity to look into a telescope. During the last transit of Mercury, and the last partial eclipses of the Sun, groups of children were noticed in many parts of the city, paying fixed attention to these events. This Society, alive to its duty, placed, on these and other occasions, in some of the schools, portable telescopes loaned by members, or by opticians. These were taken in charge by teachers, anxious to be of assistance to their pupils. One member of the Society, who at his house, showed some bright boys from an adjoining school the planet Mercury on the solar disc, was well rewarded when he saw their countenances light up with intelligence as the phenomenon was explained to them, a phenomenon easy enough to explain under the circumstances. In a few moments the lads understood that which, without practical work, no elucidation

* Since the above was written, it has been announced that Mr. Wm. Macdonald (recently deservedly knighted) has purchased twenty acres of land on Mount Royal, and that he will, on behalf of McGill College, Montreal, erect thereon and equip and endow a first-class astronomical and astro-physical observatory. As an evidence of the completeness of the equipment, it may be added that the principal telescope will be a 20-inch refractor of the highest quality.

could have made clear to their minds. Of lads like these, will come the Canadian astronomers of the future, who, we may be sure, will prove to be the equals of any, once they have the opportunity to learn. At present they have none.

Comparisons are odious and should not be made. But let us, for the sake of contrast, conceive one of these lads, with locks then whitened by Time, standing here and addressing the Astronomical Society of 1950 on the subject of the growth and cultivation of astronomy in Canada, and speaking to an audience drawn from a city and from a country where the science shall be loved and cherished for its own sake, and where, instead of being neglected, as now, it shall be in as thriving a condition as anywhere else in the world. Fancy this successor of mine painting, in words, some such picture as this:—"Ladies and gentlemen, imagine, if you can, a civilized nation, whose shores were washed by three great oceans, but within whose coasts, when I was a boy, there was not one telescope worthy of the country, and not any instrument of any kind for the use of the public. Imagine, if you can, a Province claiming to be the brightest gem in an Imperial Crown, but in whose public schools the only instruction in astronomy was limited to a few paragraphs scattered through the pages of the common school geography. Imagine, if you can, a metropolitan city of 200,000 people, asserting herself as the centre of the intellectual life of the land, and boasting the excellence of her academies and colleges, but without one class in Astronomy, or a single telescope. Imagine, if you can, two universities, in the Calendar of one of which the word 'Astronomy' was not to be found at all, and in the Calendar of the other it appeared only to refer to special work in the last year, the practical part of which could not be done on the university grounds for want of apparatus. Imagine, if you can, an examiner compelled to admit that he had set papers for fourth year men who, from memory, were able to explain the theories of certain instruments and describe their uses, but who would not have recognized them had they been shown to them, and could not have used them had they been placed in their hands." Nothing in this conception is to be understood as, in any manner, reflecting upon the Faculties of the Universities which, as is too well known, are crippled by want of funds, or upon the provincial head of our educat onal system, who cannot move faster than public opinion will allow. For that Minister it must be said that he came readily and cheerfully to the practical assistance of this Society, and those who have met him know how deep an in-

terest he takes in the subject, and how much he wishes that matters, in respect to the science generally, were on a better footing in Ontario.

If it may be permitted to add a word upon the attractiveness of the subject we have at heart and which we, apart from any selfish motive, desire to see brought in a practical way within the reach of our people, the writer would crave to be allowed to close with the eloquent words once uttered by Mitchell of Cincinnati, who, whether as college don, whether as astronomer, or whether as general in the armies of his country, never flinched from duty. In cheering on the plodding student and in defending the spirit of inquiry and the interest which should be taken by the public in astronomy, he exclaimed: "In this boundless field of investigation, Human Genius has won its most signal victories. Generation after generation has rolled away, age after age has swept silently by, but each has swelled by its contribution the stream of discovery. One barrier after another has given way to the force of Intellect; mysterious movements have been unravelled; mighty laws have been revealed; ponderous orbs have been weighed, their reciprocal influences computed, their complex wanderings made clear until the mind, majestic in its strength, has mounted step by step up the rocky height of its self-built pyramid, from whose star crowned summit it looks out upon the grandeur of the Universe, self-clothed with the prescience of a God. With resistless energy, it rolls back the tide of Time, and lives in the configuration of worlds a thousand years ago; or, more wonderful it sweeps away the dark curtain from the Future and beholds those celestial scenes which shall greet the vision of generations when a thousand years shall have rolled away. To trace the efforts of the Human Mind in this long and ardent struggle, to reveal its hopes and fears, its long years of patient watching, its moments of despair and hours of triumph, to develop the means by which the deep foundations of the rock-built pyramid of Science have been laid and to follow it as it slowly rears its stately form from age to age until its vertex pierces the very heavens; these are the objects proposed for accomplishment, and these are the topics to which I would invite your earnest attention. The task is one of no ordinary difficulty. It is no feast of Fancy, with Music and Poetry, with Eloquence and Art to enchain the mind. Music *is* here but it is the deep and solemn harmony of the spheres. Poetry *is* here; but it must be read in the characters of light written on the sable garments of Night. Architecture is here; but it is the colossal struc-

ture of Sun and system, of cluster and universe. Eloquence is here; but there is neither speech nor language; its voice is not heard. Yet its resistless sweep comes over us in the mighty periods of revolving worlds. Shall we not listen to this music, because it is deep and solemn? Shall we not read this poetry because its letters are the stars of heaven? Shall we refuse to contemplate this architecture, because its archways seem ghostly from infinitude? Shall we turn away from this surging eloquence, because its utterance is made through sweeping worlds? No; the mind is ever inquisitive, ever ready to scale the most rugged steeps. Wake up its enthusiasm, fling the light of Hope on its pathway, and no matter how rough and rocky it may prove, ONWARD is the word which charms its willing powers."

SPECTROSCOPIC NOTES.

In continuation of previous work at the Lick Observatory on the subject of the relative intensity of the bright lines in the spectrum of the Nebula of Orion, Professor Campbell contributes to the *Astrophysical Journal* for May an article describing a comparison of the hydrogen spectrum of the Nebula with the spectrum of hydrogen obtained from the gas enclosed in a Geissler tube. The Geissler tube was placed about twelve feet in front of the slit of the spectroscope, and the comparisons were secured by measuring the length of tube exposed to the spectroscope when the lines were equal. First, as much of the tube was uncovered as was necessary to make the *F* line due to the tube equal to the *F* line due to the central part of the Nebula. Then, on making the *Hγ* line due to the tube equal to the *Hγ* line of the Nebula, half as much again of the tube was required as for the equality of the *F* lines. The Nebula would seem, consequently, to be relatively stronger in *Hγ* light than the tube.

In *Astronomische Nachrichten* 3565 Sir William Huggins, in a short note preliminary to a fuller account to appear in his book of photographs of star spectra promised for early publication, announces that he is able to confirm Mr. McClean's statement as to the presence of oxygen in stars characterized by the presence of strong helium lines. In the ultra-violet about ten lines considered to belong to oxygen appear to coincide with lines in various helium stars, though the relative intensities of the oxygen lines as observed in the laboratory do not exactly agree with their relative intensities in the stars.

The appointment of Professor Wadsworth as director of the reorganized Allegheny Observatory would seem to promise that spectroscopic work is to be a leading feature; it is eminently natural and proper that the successor of Langley and Keeler should be interested primarily in astronomical physics.

The fact that the most striking feature of the spectrum of the Nova in Sagittarius, recently discovered at the Harvard Observatory, is its bright lines, has

enabled Professor Campbell to examine its spectrum visually, in spite of the fact that it was at the time as faint as the eleventh magnitude. In a communication to the *Astrophysical Journal* for May he states that nine bright lines were seen and measured; and that they agree as well as could be expected in position, and more or less well in relative intensity, with the spectrum of Nova Aurigæ after its transformation into a planetary nebula.

Before the Royal Astronomical Society May 12 Rev. W. Sidgreaves read a paper on the spectra of γ Cassiopeiæ and o Ceti. His photographs confirm previous results as to the complex character of the hydrogen lines, and as to the fact that the bright component is prominent in those lines where the dark component is weak. In γ Cassiopeiæ he finds the $H\gamma$ line invariable, but certain other lines variable in intensity. He regards the hypothesis of an extensive hydrogen envelope as possible for γ Cassiopeiæ but inadequate for o Ceti.

Herr Belopolsky contributes to *Astronomische Nachrichten* 3565 his observations on the variable velocity in the line of sight of the variable star ζ Geminorum, in response to Professor Campbell's publication. The Pulkova observations had led, it seems, to the same conclusion over a year ago. Measures are given of fifteen plates from Dec. 31, 1897, to Mar. 28, 1899, showing the velocity in the line of sight evidently variable. The case for this star seems to be much the same as for δ Cephei and η Aquilæ. The time of slowest recession for ζ Geminorum seems to come about 4½ days, that is, about two-fifths of the period of the star's light variation, after the time of minimum.

Two new stars with variable velocity in the line of sight are announced by Professor Campbell in the *Astrophysical Journal* for May, ι Pegasi and δ Draconis.

VARIABLE STARS.

J. A. PARKHURST.

Maxima and Minima of Long Period Variables

1899 OCTOBER.

MAXIMA.

		Mag.	Day.
243	U Cassiopeæ	8.0	17
893	U Ceti	6.8	17
976	T Arietis	7.9	24
2539	R Canis Minoris	7.2	20
2625	V Geminorum	8.2	2
4407	R Corvi	6.8	14
4521	R Virginis	6.5	8
5249	V Librae	9.3	29
5430	T Librae	9.2	31
5511	RS Librae	6.1	19
5831	S Scorpii	9.1	29
5928	T Ophiuchi	10	19
6044	S Herculis	5.9	26

MAXIMA, Con't.

		Mag.	Day.
6062	RR Scorpii	6.8	30
6132	R Ophiuchi	7.0	17
6512	T Herculis	6.9	11
6549	W Lyrae	8.5	13
6624	T Serpentis	9.1	13
6849	R Aquilae	5.9	10
6901	RY Sagittarii	6.1	8:
6923	Z Sagitarii	8.5	5
(7248)	- Aquilae	7.9	20
7252	W Capricorni	10.2	27
7260	Z Aquilae	8.8	9
7428	V Cygni	6.8	4
7455	U Capricorni	10.2	19

MAXIMA, Con't.

		Mag.	Day.
7492	RZ Cygni	9.1	13
7577	X Capricorni	9.5	30
7733	Y Capricorni	10	12
8068	S Lacertae	7.6	31
8230	S Aquarii	7.7	11
8290	R Pegasi	6.9	27

MINIMA.

		Mag.	Day.
107	T Cassiopeae	12.0	30
114	S Ceti	12	18
434	S Piscium	< 14.7	11
715	S Arietis	14 ?	9
1981	S Camelopardalis	12	29

MINIMA, Con't.

		Mag.	Day.
2445	W Monocerotis	< 10	21
4557	S Ursae Majoris	11.5	8
4948	R Canum Ven.	11.5	14
5194	V Bootis	10.5	26
5237	R Bootis	12.2	7
5338	U Bootis	13	8
5583	X Librae	14	28
5675	V Coronae	12	23
5955	R Draconis	13	26
7448	W Aquarii	9.6 ?	8
8600	R Cassiopeæ	12	21

NOVEMBER.

MAXIMA.

		Mag.	Day.
62	S Sculptoris	6.5	18
466	U Piscium	9.5	17
513	R Piscium	7	3
659	X Cassiopeæ	9 3	23
782	R Arietis	7 6	13
1113	U Arietis	7.0	25
1805	V Orionis	8.1	11
1894	T Columbae	7.6	29
2059	S Columbae	8.0	10
4816	V Virginis	8.0	26
5405	RT Librae	8.5	2
5566	RU Librae	8.5	1
5593	W Librae	9.5	1
5704	RR Librae	8 4	14
6871	V Lyrae	9.1	3
7155	RR Aquilae	12	29

MAXIMA, Con't.

		Mag.	Day.
7456	RR Cygni	8.1	15:
7458	V Delphini	8.9	3
7560	R Vulpeculae	7.5	15
8512	R Aquarii	5.8	13

MINIMA.

		Mag.	Day.
103	T Andromedae	13	21
494	R Sculptoris	8 0	9
845	R Ceti	13.5	23
2100	U Orionis	< 12	23
2735	U Canis Minoris	13	6
5504	S Coronae	12	4
6943	T Sagittae	9.9	13
7192	Z Cygni	12	28
7404	R Microscopii	12	14

Minima of the Variable Stars of the Algol Type.

(Given to the nearest hour in Greenwich Time.)

U CEPHEI.

	d	h
Sept.	4	18
	9	17
	14	17
	19	17
	24	16
	29	16
Oct.	4	16
	9	15
	14	15
	19	14
	24	14
	29	14

ALGOL.

	d	h
Sept.	5	21
	8	18
	11	15

ALGOL, Con't.

	d	h
	14	12
	17	9
	28	20
Oct.	1	17
	4	13
	7	10
	10	7
	18	22
	21	18
	24	15
	27	12
	30	9

S CANCRI.

	d	h
Oct.	14	23

U CORONÆ.

	d	h
Sept.	6	9
	13	7
	23	15
	30	13
Oct.	14	8
	21	6
	31	15

λ TAURI.

	d	h
Sept.	3	10
	7	9
Oct.	12	23
	16	21
	20	20
	24	19
	28	18

DM + 12°3557

	d	h
Sept.	5	17
	8	9
	13	17
	16	9
	21	17
	24	9
	29	17
Oct.	2	10
	7	17
	10	10
	15	17
	18	10
	23	18
	26	10
	31	18

DM + 45°3062*

	d	h
Aug.	6	22
	11	11
	16	1
	20	15
	25	4
	29	18
Sept.	3	8
	7	22
	12	11
	17	1
	21	15
	26	5
	30	18
Oct.	5	8
	9	22
	14	12
	19	1

DM + 45°3062* Con't.

	d	h
Oct.	23	15
	28	5
Nov.	1	18
	6	8

R CANIS MAJ.

Every 8th min.
P = 1d 3h.26

	d	h
Sept.	4	14
	13	16
	22	18
Oct.	1	20
	10	22
	20	0
	29	2

U OPHIUCHI.

Every 10th min.
P = 20h.13

	d	h
Sept.	7	5
	15	14
	23	23
Oct.	2	9
	10	18
	19	3
	27	13

RS SAGITTARII.

	d	h
Sept.	4	7
	11	13
	16	9
	23	15
	28	11

RS SAGITTARII. Con't.

	d	h
Oct.	3	7
	5	17
	10	13
	15	9
	22	15
	27	11

W DELPHINI.

	d	h
Sept.	2	18
	7	13
	12	9
Oct.	1	14
	6	9
	25	15
	30	10

SAWYER'S ALGOL-TYPE VARIABLE, DM + 12°3557, has not had a letter assigned by Dr. Chandler as yet. The ephemeris is condensed for September and October, every ninth minimum being given, the others being readily found from the period, 21h 21m, assigned by the discoverer. The minimum of Sept. 24 is number 400, and as the period was only given to the nearest minute of time the ephemeris may be in error by two or three hours.

**NEW ALGOL-TYPE VARIABLE.*—In No. 3567 of the *Nachrichten* it was announced that the DM. star + 45°3062, whose place for 1855 is

R. A. 20h 2m 25s, Dec. + 45° 52′.9,

was a variable, probably of the Algol-type. The discovery was made by Madame L. Ceraski, wife of the director, from photographs taken at the Moscow Observatory by the assistant, Mr. S. Blajko. In No. 3572 it was further announced that the period was 4d 13h 44m, the duration of variation about 13h, and the diminution in brightness 2.5 to 3 magnitudes. The following minima were deduced from the photographs and visual observations—

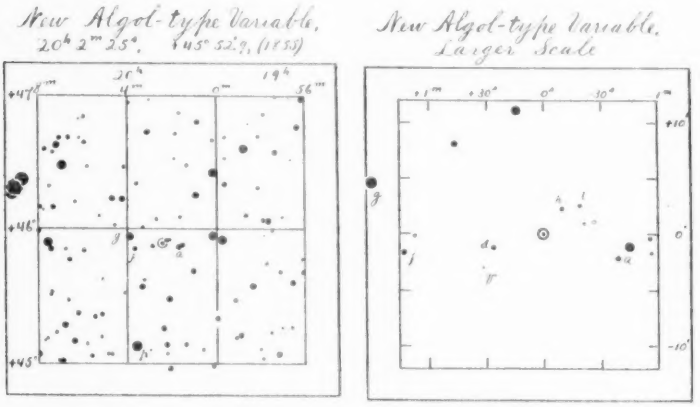
Gr.	Time.
1898	May 20.4
1899	May 7.454
	May 21.2

Assuming the second, the best determined, as the zero epoch, the first is number — 77 and the third + 3, if the period given is correct as is probably the case. I have observed the descending branches of the light curves of two minima which confirm the above period. On June 26 the star faded from 9.7 to 11.3 magnitude between 14 9h and 17.1h, Greenwich Time, and on July 5 the decline began between 15 and 16h, and it was found at 11.2 magnitude at 21h. By the above elements the corresponding minima (Nos. 11 and 13) were due June 26, 17.9h and July 5, 21.4h. These observations thus tend to confirm both the period and the duration of variation given by Professor Ceraski.

The DM. magnitude is given as 8.6, my comparisons at normal light make it about 8.75 on the scale of the DM., and 9.15 on the scale of the Harvard Meridian Photometer Catalogue.

This is almost an ideal star for observation with three inches or more

aperture. The range of variation is sufficient to make the comparisons easy, the star is in good position for evening work, and the field is readily found without circles, the variable being 1° south preceeding o^1 Cygni, which is shown as the bright coarse double on the left-hand margin of the accompanying small scale chart. The brighter component of this double is given as 3.8 magnitude in the Harvard Photometry, and the fainter as 4.9. The magnitudes on this chart range from 3.8 to 9.5. The star p^1 is 7.6 in the Durchmusterung and 8.14 in the Harvard Meridian Photometer Catalogue. The star 1^m 13ˢ preceeding p^1 is 8.8 and 9.37 in the same catalogues.



The larger scale chart shows enough of the stars between 8 and 12 magnitudes in the immediate vicinity of the variable, to identify it in its fainter stages, and to furnish comparison stars. The variable does not become brighter than *a* nor fainter than *q*.

COMPARISON STARS FOR CERASKI'S ALGOL-TYPE VARIABLE.

	Co-or. from V. R. A. s	Decl. ′	Mag.		Co-or. from V. R. A. s	Decl. ′	Mag.
p	− 57.4	+ 1.0	12	*h*	− 9.8	+ 2.2	9.3
m	− 56.0	− 1.7	10.3	*d*	+ 26.3	− 1.2	9.6
b	− 54.8	− 0.3	9.5	*q*	+ 31.4	− 3.0	12.0
a	− 44.3	− 1.1	8.6	*n*	+ 67.0	− 0.1	10
o	− 20.5	+ 1.0	10.9	*f*	+ 72.4	− 1.7	9.2
l	− 18.4	+ 2.6	9.8	*g*	+ 88.5	+ 4.3	8.2

The magnitudes of the above comparison stars are only approximate, sufficient for identification.

SS CYGNI The weather was generally unfavorable at the time of the May maximum, noted at the bottom of page 322 in the June number. Fortunately two observations were secured here at the critical time,

	Gr. T.	Mag.
1899 May	1.70	9.50
	1.90	9.24

thus fixing the time of passing 9.35 magnitude very definitely at May 1.8. The

correction to the elements given on page 148 of the March 1899 number, is — 5.7 days. The maximum was passed May 5 at 8.3 magnitude. Messrs. Daniel and Flanery kindly sent me their observations which cover the descending branch of the curve. Normal light was reached May 21, giving 20 days as the duration of activity, a typical "long" maximum as was expected. The star is passing another maximum at this writing, July 7.

PLANET NOTES FOR AUGUST AND SEPTEMBER.

H. C. WILSON.

Mercury during August and September will describe a complete loop in Leo (See chart p. 37, January No. POPULAR ASTRONOMY). The planet will be visible to the naked eye for the first few days in August, being seen directly toward the west soon after sunset. Mercury will be at inferior conjunction on the morning of August 19, at greatest elongation west from the Sun, 18° 1′, September 4 and at superior conjunction September 30.

Venus is approaching superior conjunction and is unfavorably situated for observation now, although the planet may be seen in the morning during August. In September Venus will probably be wholly invisible, reaching superior conjunction on the 15th.

Mars will be in Virgo during these months, moving southeastward, and will almost catch up to Jupiter by the end of September. Mars will be in conjunction with the first magnitude star Spica, passing 2° 20′ north of the star, on September 8.

Jupiter is moving slowly southeast in Libra, but the annual movement of the Earth is carrying the planet relatively west quite rapidly, so that it is lower in the southwest each evening. The planet is so bright, however, that good observations of its surface detail may be obtained in the twilight, perhaps better even than in the darkness of night.

Saturn is the planet for evening study during these months being near the meridian as soon as it is dark enough for observing. Its low altitude is a drawback to northern observers, but frequently the seeing is steady enough to show the marvelous structure of the rings and the numerous retinue of satellites. Saturn is turning the western end of the loop in his path in Ophiuchus being stationary in right ascension Aug. 21. Saturn will be at quadrature Sept. 10, and in conjunction with the Moon Aug. 16 amd Sept. 12. The angle of elevation of the Earth above the plane of the rings is now nearly 27° so that they are now seen at almost their widest aspect.

Uranus is near the stationary point in his annual path among the stars, in right ascension $16^h\ 8^m$ and south declination 20° 52′, about 3° southeast from the bright star β Scorpii. Uranus will be at quadrature on Aug. 27.

Neptune is in the opposite part of the heavens, seen in the morning and will be at quadrature Sept. 19. His right ascension is $5^h\ 47^m$ and declination north 22° 9′.

A couple of quite notable sunspot groups were visible in June and July but at this writing (July 20) the solar disc is as immaculate as the ancient astronomers supposed it to be.

THE CONSTELLATIONS AT 9 P. M., SEPTEMBER 1, 1899.

The Moon.

		Phases.	Rises. (Central Standard Time at Northfield; Local Time 13m less.)		Sets. (Central Standard Time at Northfield; Local Time 13m less.)	
			h	m	h	m
Aug.	6	New Moon	5	19 A. M.	7	21 P. M.
	14	First Quarter	1	47 P. M.	10	52 "
	20	Full Moon	6	38 "	5	59 A. M.
	27	Last Quarter	10	25 "	2	24 P. M.
Sept.	4	New Moon	5	15 A. M.	6	10 "
	12	First Quarter	1	41 P. M.	10	33 "
	19	Full Moon	6	0 "	7	27 A. M.
	26	Last Quarter	11	1 "	2	31 P. M.

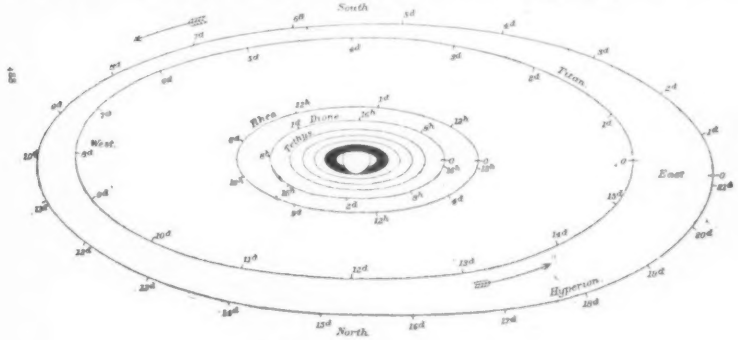
Occultations Visible at Washington.

Date. 1899.		Star's Name.	Magnitude.	IMMERSION. Washington M. T. h m	Angle from N pt. °	EMERSION. Washington M. T. h m	Angle from N pt. °	Duration. h m
Aug.	1	B.A.C. 1801	6 0	14 12	99	15 8	250	0 56
	8	55 Leonis	6 2	7 17	90	8 11	318	0 54
	15	18 Ophiuchi	6.7	8 41	81	9 59	274	1 18
	16	B.A.C. 6066	7.3	11 57	38	12 47	296	0 50
	17	ν^1 Sagittarii	5 0	8 37	114	9 39	216	1 2
	17	ν^2 Sagittarii	5.1	9 9	109	10 12	217	1 3
	17	o Sagittarii	3.8	14 4	76	14 59	247	0 55
	24	104 Piscium	7.5	9 42	52	10 37	258	0 55
	27	υ^1 Tauri	4.7	10 19	69	11 10	269	0 51
	27	υ^2 Tauri	6.0	10 52	35	11 30	303	0 38
	29	μ Geminorum	3.2	14 18	51	15 11	307	0 53
Sept.	8	83 Virginis	6.0	5 35	104	6 49	291	1 14
	12	B.A.C. 5868	7.0	5 45	22	6 21	333	0 36
	18	$\varkappa$ Piscium	4.7	11 43	70	12 55	223	1 12
	18	9 Piscium	6.6	11 55	106	12 43	187	0 48
	19	45 Piscium	6.9	13 41	62	14 54	238	1 13
	22	τ^1 Arietis	5.0	16 44	39	17 46	300	1 2
	22	65 Arietis	6.0	18 52	169	18 58	179	0 6
	23	A^1 Tauri	4.6	9 1	73	9 54	260	0 53
	25	141 Tauri	6.7	11 44	131	12 28	222	0 44
	26	ζ Geminorum	4.0	17 24	128	18 51	262	1 27
	27	g Geminorum	5.3	12 43	63	13 17	311	0 34
	30	16 Sextantis	6.9	15 17	116	16 19	285	1 2

Saturn's Satellites.

Central Standard Time.

[E = east elongation; I = inferior conjunction (south of planet); W = west elongation; S = superior conjunction (north of planet). In the diagram the points of the orbits marked O are those of eastern elongation, as seen in an inverting telescope. The Central Standard times when the satellites will be at these points are given in the tables that follow. The points on the orbits marked 1*d*, 2*d*, etc., indicate the places of the satellites at the intervals 1 day, 2 days, etc., after the time given for eastern elongation.]



I. Mimas. Period $0^d\ 22^h\ 6$.

Aug.	1	10.1	P. M.	W	Aug.	18	9.2	P. M.	W	Sept.	11	10.2	P. M.	E
	2	8.7	"	W		19	7.8	"	W		12	8.7	"	E
	3	7.3	"	W		20	6.4	"	W		13	7.3	"	E
	4	5.9	"	W		25	10.9	"	E		14	5.9	"	E
	8	11.7	"	E		26	9.5	"	E		20	9.0	"	W
	9	10.3	"	E		27	8.1	"	E		21	7.6	"	W
	10	8.9	"	E		28	6.7	"	E		22	6.2	"	W
	11	7.5	"	E	Sept.	2	11.2	"	W		28	9.3	"	E
	12	6.2	"	E		3	9.8	"	W		29	7.9	"	E
	16	12.0	Midn.	W		4	8.4	"	W		30	6.5	"	E
	17	10.6	P. M.	W		5	7.0	"	W					

II. Enceladus. Period $1^d\ 8^h.9$.

Aug.	1	7.5	P. M.	E	Aug. 22	8.8	A. M.	E	Sept. 11	10.2	P. M.	E
	3	4.4	A. M.	E	23	5.7	P. M.	E	13	7.1	A. M.	E
	4	1.3	P. M.	E	25	2.6	A. M.	E	14	4.0	P. M.	E
	5	10.2	"	E	26	11.5	"	E	16	12.9	A. M.	E
	7	7.1	A. M.	E	27	8.4	P. M.	E	17	9.8	"	E
	8	3.9	P. M.	E	29	5.3	A. M.	E	18	6.7	P. M.	E
	10	12.7	A. M.	E	30	2.2	P. M.	E	20	3.6	A. M.	E
	11	9.7	"	E	31	11.1	"	E	21	12.5	P. M.	E
	12	6.6	P. M.	E	Sept. 2	7.9	A. M.	E	22	9.4	"	E
	14	2.5	A. M.	E	3	4.8	P. M.	E	24	6.3	A. M.	E
	15	12.4	P. M.	E	5	1.7	A. M.	E	25	3.1	P. M.	E
	16	9.3	"	E	6	10.6	"	E	27	12.1	A. M.	E
	18	6.2	A. M.	E	7	7.5	P. M.	E	28	8.9	"	E
	19	3.1	P. M.	E	9	4.4	A. M.	E	29	5.8	P. M.	E
	20	11.9	"	E	10	1.3	P. M.	E	Oct. 1	2.7	A. M.	E

III. Tethys. Period $1^d\ 21^h.3$.

Aug.	2	4.9	A. M.	E	Aug. 22	11.3	P. M.	E	Sept. 12	5.8	P. M.	E
	4	2.2	"	E	24	8.6	"	E	14	3.1	"	E
	5	11.5	P. M.	E	26	5.9	"	E	16	12.5	"	E
	7	8.9	"	E	28	3.3	"	E	18	9.8	A. M.	E
	9	6.2	"	E	30	12.6	"	E	20	7.1	"	E
	11	3.5	"	E	Sept. 1	9.9	A. M.	E	22	4.4	"	E
	13	12.8	"	E	3	7.2	"	E	24	1.7	"	E
	15	10.1	A. M.	E	5	4.5	"	E	25	11.1	P. M.	E
	17	7.4	"	E	7	1.9	"	E	27	8.4	"	E
	19	4.7	"	E	8	11.2	P. M.	E	29	5.7	"	E
	21	2.0	"	E	10	8.5	"	E				

IV. Dione. Period $2^d\ 17^h.7$.

Aug.	1	5.2	A. M.	E	Aug. 23	2.7	A. M.	E	Sept. 14	12.3	A. M.	E
	3	10.8	P. M.	E	25	8.4	P. M.	E	16	6.0	P. M.	E
	6	4.5	"	E	28	2.1	"	E	19	11.7	A. M.	E
	9	10.2	A. M.	E	31	7.7	A. M.	E	22	5.5	"	E
	12	3.9	"	E	Sept. 3	1.5	"	E	24	11.2	P. M.	E
	14	9.6	P. M.	E	5	7.2	P. M.	E	27	4.9	"	E
	17	3.3	"	E	8	12.9	"	E	30	10.6	A. M.	E
	20	9.0	A. M.	E	11	6.6	A. M.	E				

V. Rhea. Period $4^d\ 12^h.5$.

Aug.	2	6.9	P. M.	E	Aug. 25	9.0	A. M.	E	Sept. 16	11.4	P. M.	E
	7	7.3	A. M.	E	29	9.5	P. M.	E	21	11.9	A. M.	E
	11	7.7	P. M.	E	Sept. 3	9.9	A. M.	E	26	12.4	"	E
	16	8.1	A. M.	E	7	10.4	P. M.	E	30	12.9	P. M.	E
	20	8.6	P. M.	E	12	10.9	A. M.	E				

VI. Titan. Period $15^d\ 23^h.3$.

Aug.	1	3.8	A. M.	I	Aug. 25	3.8	A. M.	S	Sept. 18	12.7	A. M.	I
	5	6.2	"	W	29	12.8	"	E	22	3.2	"	W
	9	5.1	"	S	Sept. 2	1.2	"	I	26	2.4	"	S
	13	1.9	"	E	6	3.7	"	W	30	11.6	P. M.	E
	17	2.2	"	I	10	2.8	"	S				
	21	4.6	"	W	13	12.0	Midn.	E				

VII. Hyperion. Period $21^d\ 7^h.6$.

Aug.	3.0	W	Aug.	24.1	W	Sept.	14.4	W
	8.6	S		29.8	S		20.1	S
	14.1	E	Sept.	4.3	E		25.5	E
	19.0	I		9.2	I		30.4	I

VIII. Japetus. Period $79^d\ 22^h.1$.

July	27.0	I	Sept.	6.0	S	Oct.	14.8	I
Aug.	16.4	W	Sept.	25.3	E			

Jupiter's Satellites for August.

Central Standard Time.

Phases of the Eclipses of the Satellites for an Inverting Telescope.

I. r *

III. d * r *

II. d * r *

IV. No Eclipse.

Configurations at 7h 30m for an Inverting Telescope.

Day.	West.	East.
1	·3 ·4	○ ·2 ·1
2	·3 ·1	○ ·4 ·2
3	·3 2· ○	1· ·4
4	·2 ·1	○ ·3 ·4
5		○ 1· ·2 3· ·4
6		○ 2· 3· 4· ·1●
7	2· 3· 1·	○ 4·
8	3·	○ ·1 4· ·2●
9	·3 1·	○ 4· 2·
10	2· ·3 4·	○ 1·
11	4· ·2 1·	○ ·3
12	4·	○ 1· ·2 ·3
13	4·	○ 2· 3· ·1●
14	·4 2·	3· 1· ○
15	·4 3·	·2 ○ ·1
16	·4 ·3 1·	○ 2·
17	·4 ·3 2·	○ ·1
18	·2 ·1	·4 ○ ·3
19		○ 1· ·2 ·4 ·3
20		·1 ○ 2· 3· ·4
21	○ 1· ○ 3· 2·	○ ·4
22	3·	·2 ○ ·1 ·4
23	·3 1·	○ ·2 4·
24	○ 2· ·3	○ ·1 4·
25	·2 ·1	○ ·3 4·
26		·2 4· 1· ·3
27	4· ·1	○ 2· 3·
28	4· 2·	○ 1· 3·
29	4· 3· ·2	○ ·1
30	4· ·3 1·	○ 2·
31	·4 ·3	○ 2· ·1

Phenomena of Jupiter's Satellites.

Central Standard Time.

		h	m					h	m			
Aug.	1	6	12	P. M.	II	Ec. Dis.	Aug. 14	8	10	"	III	Sh. In.
		8	27	"	II	Ec. Re.		8	27	"	I	Sh. Eg.
	3	8	59	"	III	Oc. Dis.		9	52	"	III	Sh. Eg.
	5	8	36	"	I	Tr. In.	17	7	53	"	II	Sh. Eg.
	8	6	14	"	II	Oc. Dis.	21	7	0	"	I	Tr. In.
		8	38	"	II	Oc. Re.		7	15	"	III	Tr. In.
		8	49	"	II	Ec. Dis.		8	10	"	I	Sh. In.
	13	7	41	"	I	Oc. Dis.	22	7	28	"	I	Ec. Re.
	14	6	15	"	I	Sh. In.	29	6	7	"	I	Oc. Dis.
		7	15	"	I	Tr. Eg.	30	6	46	"	I	Sh. Eg.

COMET NOTES.

New Elements of Comet Temple, 1899 c.—In *Astronomische Nachrichten*, No. 3574, Dr. Schulhof, of Paris, gives provisionally corrected elements of this periodic comet and continues the ephemeris to November. The comet should be at its brightest now and will be favorably situated for observation with a telescope during August and September.

ELEMENTS.

Epoch 1899, Sept. 6.0 Paris M. T.

$$\left.\begin{aligned} M &= 7^\circ\ 21'\ 50''.5 \\ \omega &= 185\ \ 36\ \ 20.0 \\ \upsilon &= 120\ \ 57\ \ 56.3 \\ i &= 12\ \ 38\ \ 52.6 \end{aligned}\right\} 1899.0$$

$$\varphi = 32\ \ 49\ \ 38.7$$

$$\mu = 671''.9166$$

EPHEMERIS.

		R. A. h	m	s	Decl. °	′	″	log Δ	Aberration. m	s	Br.
Aug.	2	20	55	3.2	− 25	11	40	9.5768	3	8	
	3		56	14.6	25	43	7	9.5780			
	4		57	26.2	26	14	6	9.5794	3	9	3.587
	5		58	37.9	26	44	34	9.5811			
	6	20	59	49.8	27	14	29	9.5829	3	11	
	7	21	1	1.9	27	43	48	9.5850			
	8		2	14.3	28	12	29	9.5871	3	13	3.447
	9		3	26.9	28	40	30	9.5895			
	10		4	39.8	29	7	48	9.5921	3	15	
	11		5	53.1	29	34	21	9.5948			
	12		7	6.8	30	0	7	9.5976	3	17	3.265
	13		8	20.8	30	25	7	9.6006			
	14		9	35.2	30	49	17	9.6038	3	25	
	15		10	49.9	31	12	38	9.6071			
	16		12	5.1	31	35	7	9.6106	3	23	3.051
	17		13	20.7	31	56	45	9.6142			
	18		14	36.7	32	17	30	9.6179	3	27	
	19		15	53.1	32	37	21	9.6217			
	20		17	9.9	32	56	20	9.6256	3	31	2.820
	21		18	27.1	33	14	24	9.6297			
	22		19	44.7	33	31	35	9.6338	3	35	
	23		21	2.6	33	47	51	9.6381			
	24		22	20.9	34	3	14	9.6425	3	39	2.580
	25		23	39.5	34	17	42	9.6469			
	26		24	58.5	34	31	17	9.6515	3	43	
	27		26	17.9	34	43	59	9.6561			
	28		27	37.6	34	55	48	9.6608	3	48	2.340
	29		28	57.7	35	6	45	9.6656			
	30		30	18.1	35	16	49	9.6704	3	53	
	31		**31**	38.9	**35**	**26**	**2**	9.6753			

		R. A.			Decl.			log Δ	Aberration.		Br.
		h	m	s	°	′	″		m	s	
Sept.	1		33	0.1	35	34	24	9.6803	3	59	2.104
	2		34	21.7	35	41	56	9.6853			
	3		35	43.7	35	48	38	9.6904	4	4	
	4		37	6.1	35	54	31	9.6956			
	5		38	28.9	35	59	37	9.7008	4	10	1.888
	6		39	52.0	36	3	55	9.7060			
	7		41	15.6	36	7	27	9.7113	4	16	
	8		42	39.6	36	10	15	9.7166			
	9		44	4.0	36	12	18	9.7220	4	23	1.683
	10		45	28.8	36	13	39	9.7273			
	11		46	54.0	36	14	18	9.7382	4	29	
	12		48	19.6	36	14	17	9.7382			
	13		49	45.5	36	13	35	9.7437	4	36	1.495
	14		51	11.8	36	12	15	9.7492			
	15		52	38.5	36	10	17	9.7547	4	43	
	16		54	5.4	36	7	43	9.7602			
	17		55	32.7	36	4	33	9.7657	4	51	1.324
	18		57	0.2	36	0	50	9.7713			
	19		58	27.9	35	56	33	9.7769	4	58	
	20	21	59	55.9	35	51	44	9.7824			
	21	22	1	24.0	35	46	24	9.7880	5	6	1.170
	22		2	52.4	35	40	33	9.7936			
	23		4	21.0	35	34	14	9.7992	5	14	
	24		5	49.8	35	27	25	9.8048			
	25		7	18.8	35	20	9	9.8105	5	22	1.033
	26		8	48.0	35	12	27	9.8161			
	27		10	17.3	35	4	18	9.8217	5	31	
	28		11	46.8	34	55	43	9.8273			
	29		13	16.5	34	46	44	9.8329	5	39	0.911
	30		14	46.4	34	37	22	9.8386			
Oct.	1	22	16	16.5	− 34	27	37	9.8442	5	48	

Rediscovery of Holmes' Comet (1892 III).—This comet was found by Perrine at Lick Observatory on the morning of June 11, very near the predicted place. The correction to Zwiers' ephemeris was − 22ˢ in R. A. and − 4′ in Decl., corresponding to a correction to the time of Perihelion of 0.40 days. Mr. Perrine describes the comet as very faint in the 36-inch telescope, a round nebulous mass about 30″ in diameter with only a slight brightening in the center.

Barnard's Periodic Comet 1892 V.—From *The Journal* of the British Astronomical Association we learn that M. Coniel has published in the *Bulletin Astronomique* for June search ephemerides for Barnard's comet 1892 V, which was discovered photographically and found to have a period of between six and seven years. The following are the limiting points between which the search should be carried on:

	From			To		
	R. A.		Decl.	R. A.		Decl.
	h	m	°	h	m	°
July 29	22	57	+ 45.1	1	21	+ 39.6
Aug. 10	23	11	47.4	1	59	39.6
22	23	26	48.3	2	36	38.0
Sept. 3	23	40	47.3	4	52	19.8
15	23	54	43.5	5	21	14.0
27	0	8	36.0	6	14	+ 3.8
Oct. 9	0	24	24.3	6	31	− 2.3
21	0	40	+ 10.2	6	12	6.8
Nov. 2	0	56	− 2.4	6	16	13.6
14	1	14	− 11.2	6	13	− 19.3

Ephemeris of Comet 1898 VII.

Aug.	1	5	10	33.11	+ 0	42	48.0		
	3		11	34.28	0	46	40.6	0.6634	38 14
	5		12	32.94	0	50	18.6		
	7		13	29.04	0	53	42.7	0.6622	38 7
	9		14	22.50	0	56	53.3		
	11		15	13.25	0	59	50.9	0.6607	37 59
	13		16	1.26	1	2	36.1		
	15		16	46.46	1	5	9.3	0.6501	37 50
	17		17	28.80	1	7	31.1		
	19		18	8.22	1	9	41.8	0.6572	37 41
	21		18	44.69	1	11	42.1		
	23		19	18.12	1	13	32.4	0.6552	37 31
	25		19	48.50	1	15	13.2		
	27		20	15.73	1	16	44.9	0.6531	37 20
	29		20	39.76	1	18	7.9		
	31		21	0.53	1	19	22.9	0.6507	37 8
Sept.	2		21	17.95	1	20	30.5		
	4		21	31.98	1	21	31.4	0.6483	36 55
	6		21	42.56	1	22	26.0		
	8		21	49.65	1	23	15.0	0.6458	36 42
	10		21	53.19	1	23	59.2		
	12		21	53.14	1	24	39.1	0.6432	36 29
	14		21	49.47	1	25	15.4		
	16		21	42.16	1	25	48.9	0.6406	36 16
	18		21	31.15	1	26	19.9		
	20		21	16.44	1	26	49.2	0.6379	36 3
	22		20	57.99	1	27	17.5		
	24		20	35.79	1	27	45.3	0.6353	35 51
	26		20	9.84	1	28	13.3		
	28		19	40.09	1	28	42.3	0.6328	35 38
	30	5	19	6.54	+ 1	29	12.9		

GENERAL NOTES.

Our delay in issuing for July and August is due to the loss of two proofs of an important article the like of which has not occurred in years before. We are not yet sure that our splendid mail service is at fault in these instances.

Our next issue for September and October will appear about the first of the last named month.

Professor M. Updegraff, Director of the Observatory of the University of Missouri, has been appointed to the position of Professor of Mathematics in the Naval Observatory, Washington, D. C.

News items of general interest to astronomy are solicited from all readers. Some thought in this matter on the part of each will benefit many readers.

L. O. Wadsworth has been appointed Director of the Allegheny Observatory. Mr. Wadsworth held a prominent position at the Yerkes Observatory before his appointment to the last important position. He was in charge of the shops, and had already in progress two lines of work, viz: the mechanical and optical, both of which were needed to equip the Observatory for its work. He had also begun, two years ago, the grinding of a 24 inch mirror, as well as some other pieces of apparatus to be used in physical research. With Mr. Brashear so near at hand, and Mr. Wadsworth in charge of the new Observatory, Astronomy may

expect large things from the place which Langley, Very and Keeler have made famous years ago.

The Third Conference of Astronomers and Astrophysicists.—The committee charged with the selection of a time and place for holding a third conference of astronomers and astrophysicists met in the city of Washington on February 8, 1899, and by unanimous vote of the members present, Messrs. Newcomb, Morley, Hale and Comstock, resolved that such a conference should be held at the Yerkes Observatory early in the following September, the precise date to be subsequently determined by Professor Hale. In accordance with this resolution and at Professor Hale's invitation the Conference will be held at the Yerkes Observatory, Williams Bay, Wisconsin, beginning on Wednesday, Sept. 6 and closing on Friday, Sept 8.

In its plan and scope this conference will be similar to those held in 1897 and 1898 at Williams Bay and Cambridge, accounts of which have been published elsewhere. The committee charged with perfecting a plan for the organization of a permanent society of astronomers and astrophysicists to have charge of future conferences will present its report at this time.

A circular giving information regarding local arrangements will be issued shortly. GEORGE. C. COMSTOCK.

Potsdam Measures of Photographs for the Astrographic Chart.—The first volume of 473 pages of the Astrographic Chart, which has been published is from the Potsdam Observatory, H. C. Vogel, director. It will be remembered that the planning for this photographic survey of the Heavens began in May, 1887, at Paris where was gathered an international congress of astronomers to consider ways and means for this work, so as to carry it forward speedily and effectively; for at this time, the efficiency of photography had not been thoroughly tested, neither were the dry, sensitive plates yet in use generally. Two years later in 1889, the best of American astronomers had not had experience enough with the standardized quick plates to know how to expose them properly for the best results in the eclipse work of that year. Fortunately, however, many of the trial exposures were quite successful. From this it will be seen how new was the great undertaking to make a photographic survey of the entire celestial sphere, in the hope of getting from it a better star catalogue than now exists. But the work was begun and it has been pushed forward since with unexpected rapidity, considering the many new things to be learned and the unforeseen hindrances that have stood in the way.

The Potsdam photographic work is zone $+31^\circ$ to $+40^\circ$ and if the whole zone is covered it would make about 3150 square degrees out of 40,276 square degrees, the entire surface of the celestial sphere. The number of photographs which have been taken in this zone, at Potsdam is said to be 1232, and the measures of 57 of these with explanatory matter constitutes the first volume. The stars on these 57 plates are 20 627, which include those as small as the 11th magnitude. It is apparent that if the work at Potsdam is done in this way for the whole zone it will require 20 large volumes to complete it. If the other observatories sharing in the international survey follow the same plan, the publications of all will make a respectable library. It is probable that the international committee will make some provision by which the results of this important work shall be put in smaller compass and finally be published at a reasonable charge so as to be within the reach of astronomers generally, who will need it as a stand-

ard star catalogue for reference. The Potsdam astronomical work is always of the best.

The Alvan Clark Workshop.—Being on an errand to Boston recently, the writer called at the Alvan Clarke workshop. Twenty years ago we called and found the Clarkes at work, but today they are lamentably absent, and their former and faithful helper, Mr. Carl Lündin, has been deemed worthy of being placed in charge by the managers of the estate. The old testing tube and chimney are still there. Mr. Lündin has orders for small telescopes and other optical work, and is well educated in the art of finishing surfaces.

One can not help thinking as the century closes of the remarkable lingering here. What strides from what humble beginnings. This in Galileo's time would have been too much. The whole world has been led by the Clarkes to better seeing among the stars. We should encourage a suitable record, and make it in enduring granite over their graves. But of the century coming, "Watchman, what of the night?" The writer wishes every finisher of surfaces well. Our United States has none too many. It may be prudently said, every test yet made of John A. Brashear's make him one of the coming men of coming years and we know of no brighter record than his. We await the thirty-inch surfaces at Allegheny Observatory. But not least is the literary record, see the columns of the Scientific American Supplement, Mr. Brashear's articles on the delicate measurement of surfaces, written in other years.

On the side of reflector surfaces, Mr. Ritchey has a five foot surface in hand and Rev. Jno. Peate has finished and shipped his 62-inch surface to the University authorities at Washington, D. C. We shall see when these surfaces are mounted what these workmen of America can do as compared with the English Dr. Common and Sir Howard Grubb and the French Brothers Henry. The writer was present at Greenville, Pa., during many hours of the year's work done by Mr. Peate. We do not believe the Allegheny workshop is a whit behind the highest record in reflecting surfaces and we have no fear that any country will produce a finer surface than that workshop will produce. We go to the Framingham, Mass., Chautauqua with means to show celestial objects by invitation next week.

REV. EDWARD D. VANCE.

WORCESTER, Mass., 8 Boynton St.
July 19, 1899.

Variation of Latitude.—Charles L. Doolittle, Director of the Flower Observatory, University of Pennsylvania, has published part II, Vol. I of Astronomical series of papers, giving results of astronomical work at that Observatory, with the zenith telescope from October, 1896 to August 1898. This paper is devoted to a continuation of the study of the change of latitude which was begun by the author a number of years ago, while at the Sayre Observatory, South Bethlehem. The plan adopted for the pursuit of work on this interesting problem was that proposed by Dr. F. Küstner in 1890,* four groups of stars being employed which were distributed in right ascension, as follows:—

Group I	5^h	28^m	to	7^h	9^m	10 pairs.
II	12	49	"	14	52	10 "
III	17	19	"	19	26	10 "
IV	21	29	"	23	28	9 "

Astronomische Nachrichten, Bd. 126, No. 3,015.

By this arrangement when one group of stars culminated in the evening, the adjacent one would do so in the morning, thus making it possible to observe them two and two throughout the entire period. Such a programme was not a convenient one for the observer as it was followed, because the morning groups were observed throughout the year at times ranging from 1 o'clock A. M. to sunrise, as particular attention was given to securing all observations at such times as the groups culminated symmetrically with respect to midnight.

Between the dates mentioned above Professor Doolittle made 3,213 individual determinations of latitude, and he has shown the result of his work, in a diagram which contains a curve indicating the change of latitude at Philadelphia for the cycle mentioned above. The unit ordinate in the squared diagram is 0.″025, or two hundred and twenty-five ten thousandths of a second of arc, the corresponding abscessa is ten days. The entire range of the curve in latitude is closely 0.″4155, or less than one half of a second of arc, which, in other language would be a variation of latitude of 40 feet approximately during the year.

Another feature in the discussion of these results is noteworthy, and that is the constant of aberration that appears in the course of the work. The value obtained is 20.″580. This large value seems necessary properly to harmonize the evening and morning observations. This careful piece of astronomical work will be read with general interest.

Greenwich Observatory.—The report of the Astronomer Royal, W. H. M. Christie, read at the Annual Visitation, June 3, 1899, is a paper of more than usual interest relating to the condition and work of the Royal Astronomical Observatory at Greenwich.

Points of general interest noted are, the near completion of the new Observatory building; the unusually large number of meridian observations during the first three months of 1899, being 1,200 more than the average for the last three years; the apparent correction for discordance between nadir observations and stars obtained by reflection for 1898, found to be —0″.36, somewhat larger than for previous years, though not due to errors by the new steel screws of the micrometers; the new determination of the co-latitude of the transit-circle by the aid of 600 stars in 1898, corrected for Chandler's variation of latitude, showing a change in co-latitude of one-fourth of a second of arc; the copy for press of the New Ten-Year Catalogue of Stars (1887-1896) containing 6,950 nearly completed; the work of the 26-inch and the 28-inch refractors respectively, the double star measures by the latter instrument especially noticeable, the unpublished measures of 128 doubles having been sent to Professor S. W. Burnham of Chicago for his new double-star catalogue; the zone observations; and the spectroscopic and the photographic work.

It appears from this interesting report that the work of the Observatory, in its various branches, compares well with that of previous years. The meridian observations are more accurate because division-errors are better known. The difficult measures of close double stars by the 28 inch telescope are useful results. The Astrographic Catalogue is so far along that the publication of results has already begun. The work of the new Thompson Photographic Equatorial in its series of pictures of the planet Eros and of Neptune's satellite shows what may be expected from new instrumental aid at the Observatory. The great old Observatory is well maintaining its past noble record.

Observatory of Yale University—The report of Dr. W. L. Elkin, Director, to the Board of Managers, for the year 1898-99 was made June 12 and

shows the following outline of astronomical work: That the heliometer has been employed during the past year in securing final measures for the parallax series on stars of large proper motion, and that the reduction of the results are nearly completed. Dr. Chase has continued his investigation on the refraction of highly colored red stars, for greater certainty of results previously obtained which show that systematic errors from this source can scarcely be feared in the use of the heliometer, so that further discussion of parallax results seems hardly necessary.

By a grant from the National Academy of Sciences, a second station for photographic observation of meteors was put up at Hamden, two miles north of the Observatory. The apparatus used was a simple form of equatorial mounting without clockwork which carried four cameras with portrait lenses of about five inches aperture. This station began work in August last, under the direction of Dr. Chase. Unfavorable circumstances prevented observations of the Perseids only one of which was recorded at either station. Watch was kept for the Leonid shower from Nov. 12 to Nov. 16, and complete records were obtained on the two nights, Nov. 14 and Nov. 15. On these nights the records gave 16 meteor trails on the plates at the two stations, 10 at the Observatory, and 6 at Hamden, 8 of which were Leonids. Four meteors were recorded at both stations, but unfortunately only one of them was a Leonid. A discussion of the results indicates high value for the photographic method and astronomers who use it in the future may do so hopefully, as we know from our experience during the last year.

It will be remembered that it was on these plates that Dr. Chase found the new comet as a by-product, which afterward bore his name.

In the Geminid shower of Dec. 11, 1898, which was quite pronounced, two meteors were secured at both stations. Two other sporadic meteors were photographically recorded at both stations at this epoch, but the Orionid, Andromedid, Quadrantid and Lyrid showers were unproductive this year, although carefully watched.

The officers of the Observatory are Dr W. L. Elkin, Director, Robert Brown, Secretary, and Dr. F. L. Chase, Assistant Astronomer.

Professor S. Newcomb at the Royal Astronomical Society.—At the meeting of the Royal Astronomical Society, June 9, Professor Simon Newcomb was present and spoke as follows, as reported in July *Observatory*: "I must thank you for this very warm greeting, which I am glad to say is not the first I have received from this Society. I am afraid I have no important scientific communication to make, but you may possibly be interested in some remarks on a subject in which the Society plays a very great part. In the year 1877, I had the honor of presiding over the American Association for the Advancement of Science at Nashville. During that time I was informed by the people of that city that there was a young man, a little over twenty years of age, who was a photographer, and had a reputation as a coming astronomer. With his scanty earnings he had bought a small telescope, and with it was trying to explore the heavens. I expressed a wish to see him, and found he was very desirous of doing something that might be useful in astronomy, and wanted to know if I could tell him what that something should be. I suggested that there was an unexplored field of work in the photography of comets. I never discovered a comet myself, and my ideas were rather theoretical, but I gave him the best instruction I could and we parted. For the remainder of my tale we must go

ahead 18 years. About two years ago the Gold Medal of this Society was awarded to this same young man. He came across the Atlantic to receive it, but the ship in which he came encountered extraordinarily bad weather, and the result was at the moment when the medal was being awarded in this room, he was passing up the Solent, and he arrived a day after the fair. You, however, did not deprive this man of the pleasure of being received by this Society on account of the delay which happened to him, and, accordingly, I understand an additional meeting, where you had Professor Barnard present. I must assure you that the circumstance of that extra meeting being arranged gave a great deal of pleasure in America, and I wish to express my high appreciation of the spirit which was shown on that occasion.

The Leonids Next November.—Dr. Johnstone Stoney presented a paper at the June meeting of the Royal Astronomical Society giving ephemerides of the ortho-leonids. From a published account of the paper in the July *Observatory*, it appears that the dense part of the great procession of meteors will probably be streaming across the Earth's orbit next November. The Earth will reach the node probably not far from " Nov. 15^d 18^h. "At that time were it not for moonlight an end-long photograph of the part of the stream which is near the Earth, but outside the atmosphere, might perhaps be secured by pointing the telescope along the tangent of the meteoric orbit, which would require it to be pointed towards a spot in the heavens some degrees distant from the radiant point. But as the Moon will be nearly full it seems hopeless to obtain the photograph."

It would seem that the ephemerides have been prepared, because some astronomers have promised to make the attempt to get some photogtaphs of the stream in this way, although no one on the other side of the water feels very hopeful of success. In the discussion of this matter some points of interest came out that will interest our readers who may not have access to the original papers.

One was concerning the light by which the meteors may be seen. It is apparent that the light of meteors must be light reflected from the Sun when they are beyond the Earth's atmosphere. The amount of this reflected light must be exceedingly small, and if the meteors are not closely packed even to overlapping, it will probably be impossible to secure any traces on the plate as exposure is made and they move across it. If it were possible to point the telescope at a portion of the stream in motion directly toward the observer the possibility of getting a photograph would be increased.

Another point was mentioned which may prove a most important one. It was in regard to the special perturbations upon the Perseid stream when near the Earth caused by her attraction. It must be that these perturbations are considerable, and since the ephemerides referred to above have not taken them into consideration in obtaining the apparent places of the stream or portions of the stream failure may result on this account.

Observations of Twenty-three Variable Stars by the Late George Knott.—By favor of Mrs. Knott, we have a copy of the observations of twenty-three variable stars by the late George Knott, which are edited by H. H. Turner, Savilian Professor of Astronomy in the University of Oxford, England. The copy is a reprint from the Memoirs of the Royal Astronomical Society, Vol. LII.

These observations were made by Mr. Knott during the years 1860 to 1894. Shortly after the death of Mr. Knott which occurred Oct 8, 1894, his relatives consulted Professor Turner, who was then Secretary of the Royal Astronomical

Society in regard to the publication of them, Mrs. Knott herself signifying a desire to contribute generously toward the expense of such publication. Upon examination of the records of observation made by Mr. Knott they were found to be so well kept as to be quite ready for the printer, and on advice of Dr. S. C. Chandler of Cambridge, this country, Professor Turner decided to publish them in full, and his opinion was sanctioned by the Council of the Royal Astronomical Society.

The telescope used by Mr. Knott was a 7⅛ inch equatorial by Alvan Clark obtained through the Rev. W. R. Dawes in 1859. The introduction to this Memoir is by Professor Turner and contains 22 pages closing with a table of the 23 stars; the first column the star's name, the second and third right ascension and declination reduced to place for 1900.0; fourth, total number of nights of observation; fifth, day of the century, then day of the year, max. or min. and finally magnitude. The list of stars is as follows:—

U Cephei	*U* Canis Minoris	*R* Cygni
U Tauri	*U* Geminorum	*S* Cygni
T Tauri	*U* Cancri	*S* Aquilæ
R Aurigæ	*R* Ursæ Majoris	*U* Cygni
S Orionis	*S* Ursæ Majoris	*T* Dephini
R Canis Minoris	*S* Coronæ Borealis	*R* Vulpeculæ
V Geminorum	*R* Scorpii	*T* Cephei
S Canis Minoris	*S* Scorpii	

American variable-star observers will be interested in these early records, and they will find this a useful volume of reference.

Three-and-a-Half-Inch Telescope is advertised for sale on first page following reading matter in general notes of this issue. Particular attention is called to this advertisement.

Carpenter's Geographical Reader.—This new book of 352 pages aims to give its readers a living knowledge of some of the wonders of North America, in 45 short, well written chapters. In plan it is like its companion which was briefly noticed in a previous number of this publication. It consists of a tour of visitation to the most important places in the United States, British America, Mexico, and Central America to learn about the people of these countries, how they live, what they know and to give some idea of what they can do. The chief part of the journey is in the United States, and it is herein that the attention of American young people will be caught and held, in view of the marvels of wealth, prosperity and undeveloped resources which our great country possesses. The chief cities with their many attractions, the cotton and tobacco industries of the South, the orange groves of Florida, the corn and wheat of the North, the vast and varied mining interests, the valuable forests, the great natural wonders like Niagara Falls, the Grand Canyon of Colorado, the big trees of California and the geysers of the Yellowstone Park are topics of such interest and so well described in this book that the minds of young or old will never tire of hearing about them. One of the most attractive features accompanying the text is the colored maps of N. America, United States, Alaska, British America, Mexico and Central America. They are all good specimens of the printer's art, and up to date in the geography of political divisions. There are 203 fine illustrations in half-tone and wood-cut work, everyone of which seems to be well planned as an illustration of the text, as well as being well engraved and faultlessly printed. In these respects the book is very pleasing to the eye of all readers whether they are or not of a critical cast of mind.

The publishers are the American Book Company of New York, Cincinnati and Chicago.